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GRAPHICAL TRAJECTORY COMPENDIUM OF CALIBER .50 AND 20 mm PROJECTILES IN AN AIR TO GROUND AND GROUND TO GROUND ROLE

October 1973

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Munitions Development & Engineering Directorate

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Air to Ground	Time of Flight	M2
Caliber 50	Trajectories	M8
Cannon Caliber Ammunition	PRU-31B	M55
Ground to Ground	20MM	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report is a compendium of trajectories in air to ground and ground to ground role of projectiles shapes of possible interest in cannon caliber ammunition applications. The 20MM projectiles shapes are M53, M56 and SAPI. The caliber 50 drag curves are the M2 and M8.

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INTRODUCTION

The data compiled in this report provides engineering information needed in making evaluations of ammunition improvements. Representative Caliber .50 and 20 mm projectiles data appear in the form of computer generated plottings of trajectories for both air to ground and ground to ground roles. Specific information covers time, velocity, and altitude versus range. Projectile characteristics include muzzle velocity, weight and shape with preformance interests centered on time of flight, muzzle velocity and maximum range effectiveness. Air to ground roles include fixed wing and helicopter launchings.

Seven 20 mm and six Caliber .50 projectiles variations listed in Table I comprised a cross section of nose shapes and weights for the study. Aside from potential application to the air to ground and ground to ground roles these projectiles studies have accumulated quantities of experimental information needed for the study.

Table I
Projectile Studies

ITEM	PROJECTILE	WEIGHT GRAINS	NOSE SHAPE
1	20mm M56A3	1540	Blunt - M505 Fuze
2	20mm M56A3	1950	Blunt - M505 Fuze
3	20mm M56A3	2100	Blunt - M505 Fuze
4	20mm PGU-3/B	1875	Secant Ogive - SAPI
5	20mm PGU-3/B	1900	Secant Ogive - SAPI
6	20mm PGU-3/B	2100	Secant Ogive - SAPI
7	20mm M53	1540	Blunt - M505 Fuze
8	Cal. .50 M8	662	Tangent Ogive
9	Cal. .50 M8	850	Tangent Ogive
10	Cal. .50 M8	1130	Tangent Ogive
11	Cal. .50 M2	662	Tangent Ogive
12	Cal. .50 M2	850	Tangent Ogive
13	Cal. .50 M2	1130	Tangent Ogive

METHOD

TRAJE (computer program) is a point mass trajectory program incorporating variation of air density with altitude by means of a subroutine, Atmospheric Computer Program, ATMS1, (1). The basic TRAJE model (2) is

$$m \frac{d\overline{V}}{dt} - \rho(y)\, A \left| V \right| \overline{V} \quad C_D(V) - \overline{g}$$

m = Projectile weight,

$\overline{V}$ = Velocity along trajectory, ft/sec

$\rho(y)$ = Air density as a function of height,

A = Projectile cross section area,

$\overline{g}$ = Gravitational constant along trajectory

$C_D(V)$ = Drag coefficient as a function of velocity.

Inputs consists of projectile weight and cross sectional area, projectile muzzle velocity and drag curve, vehicle velocity and angle of ascent or descent. Outputs include altitude, range, velocity, time of flight and drag in machine plotted form. Output information is used to compare trajectories, time of flight and velocity decay of various projectiles.

Figure 1 contains curves (3) of drag coefficient versus mach number for projectile items number 1, 4, 7, 8, and 11. Appendix A contains a listing of card types for the program data inputs, and the units for the various parameters. The program is written in Fortran IV for use on the IBM 360 or CDC 6500.

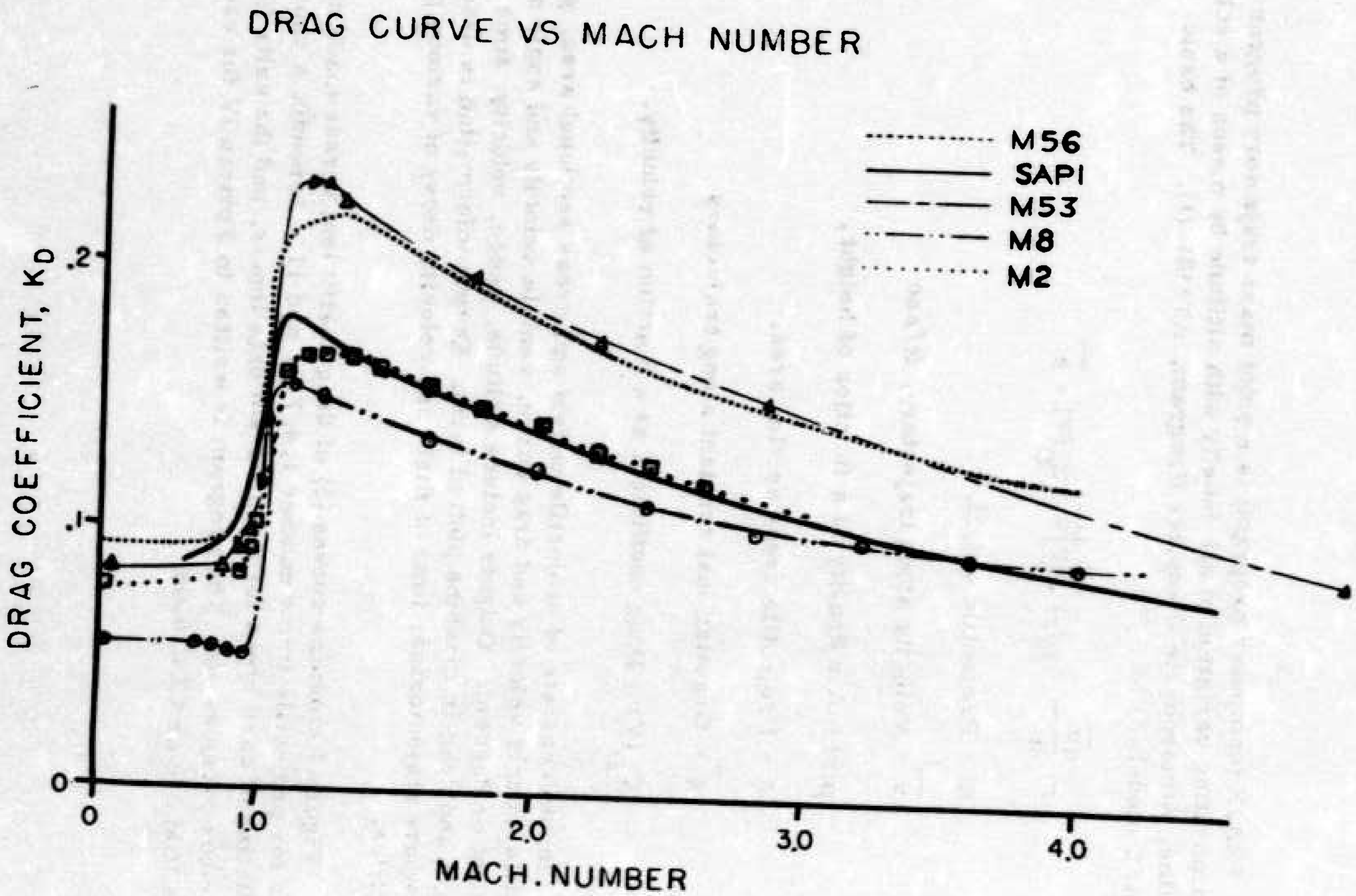


Figure 1. Drag Coefficient Curve

RESULTS

A series of graphs (Appendex C) present the charted data generated during the course of the study for altitude, time, and velocity versus range for each of the projectiles investigated. These graphs present various combinations of the same basic curves to provide comparisons in graphic form. Tables II to V contain listings of these graphs. Table II covers graphs 1 through 27 for 20 mm projectiles launched in the air to ground role at a constant aircraft velocity of 790 knots and a dive angle of 30° from two different altitudes, 182.88 x 10 meters (6000 ft) and 213.36 x 10 meters (7000 ft). The notations in the column headed "drag Curve" refers to the M505A3 fuze or nose shape of the M56A3 projectile as M505 and to the nose shape of the 20 mm PGU-3/B projectile as SAPI. These terms also appear in the legend of the plots and in Table I and are used to identify the drag curve used in the calculations.

Graphs 1 and 2 compare projectiles of two different weights having the SAPI nose launch at two diferent altitudes. Graphs 3 and 4 compare projectiles having the M505 nose shape, same weights, but different muzzle velocities launched at two different altitudes. Graphs 5 and 6 provide the same comparison for projectiles having the SAPI nose shape. Graphs 7 through 12 compare projectiles having M505 and SAPI nose shapes at two weights and three velocity levels launched at two altitudes. Graphs 13 through 16 present a comparison of the M505 and SAPI nose shapes at two launch altitudes by interchanging projectile weights. Graphs 17 and 18 compare SAPI nose shapes at two launch altitudes and projectile weights and three velocities. Graphs 19 and 20 cover the same comparison for the M505 nose shape. Graphs 21 and 22 compare a projectile having the standard M56A3 weight with M505 and SAPI projectiles having the same weights. Graphs 23 and 24 present a comparison of five projectiles, SAPI and M505 projectile nose shapes at two different weights and the standard M56A3. Graph 25 compares the standard M56A3 weight projectile to two heavier M505 and SAPI nose shape projectiles. Graph 26 compares equal weight and velocity M505 and SAPI projectile shapes with standard M56A3. Graph 27 includes the M53 API data for comparison with the M56A, M505 and SAPI nose shaped and weight projectiles.

Table III contains a listing of Graphs 28 through 76 together with identification of the conditions for the graph data. These conditions

differed from those identified in Table II by varying altitude and aircraft speed at lower levels and dive or descent angles. The range selected relates to helicopter launchings. Four projectiles were considered: standard M53, one with M505 nose shape, and two SAPI nose shaped projectiles differing in weight and velocity. Each graph contains four sets of data, one set for each projectile. Table III groups the graphs according to aircraft velocity: Graphs 28 through 37 are for 0 forward velocity while Graphs 68 through 76 are for 200 knots air speed with the other graphs, 38 to 67, grouped for velocities in between.

Table IV lists 24 graphs covering trajectory data for 20 mm projectiles in the ground to ground role at elevations in the 3^{o} to 60^{o} range. Projectiles having M505 and SAPI nose shapes at two velocity levels are compared at one weight level together with the standard M56A1 weight projectile. Graphs 77 through 89 cover one velocity level and Graphs 90 through 100 another for the M505 and SAPI nose projectiles.

Table V contains a listing of the graphs presenting Caliber .50 data. The data involves two Caliber .50 type nosed projectiles, M2 and M8, launched at three different weights over an elevation angle range of 1^{o} to 60^{o}. Graphs 101 through 120 relate to the M2 data and Graphs 121 through 140 to the M8 data.

Table II.
20MM Projectiles, Air to Ground Trajectories
Aircraft Velocity 790 Knots, Dive Angle 30°

Graph Number	Altitude Ft/Meters	Drag Curve	Weight Grains	Muzzle Velocity fps/mps
1	6000/1828.8	SAPI	1950	2950/899.16
		SAPI	1850	3016/919.28
2	7000/2133.6	SAPI	1950	2950
			1850	3016
3	7000	M505	1950	3050/929.64
		M505	1950	2950
4	6000	M505	1950	2950
		M505	1950	3050
5	7000	SAPI	1950	3050
		SAPI	1950	2950
6	6000	SAPI	1950	2950
		SAPI	1950	3050
7	7000	M505	1950	2950
		SAPI	1950	2950
8	6000	SAPI	1950	2950
		M505	1950	2950
9	6000	SAPI	1950	3050
		M505	1950	3050
10	7000	M505	1950	3050
		SAPI	1950	3050
11	7000	M505	2100	2850
		SAPI	2100	2850
12	6000	SAPI	2100	2850
		M505	2100	2850
13	7000	SAPI	2100	2850
		M505	1950	2950
		M505	1950	3050
14	6000	SAPI	2100	2850
		M505	1950	3050
		M505	1950	2950
15	7000	M505	2100	2850
		SAPI	1950	3050
		SAPI	1950	2950
16	6000	M505	2100	2850
		SAPI	1950	2950
		SAPI	1950	3050
17	7000	SAPI	2100	2850
		SAPI	1950	3050
		SAPI	1950	2950
18	6000	SAPI	2100	2850
		SAPI	1950	3050
		SAPI	1950	2950
19	6000	M505	2100	2850
		M505	1950	2950
		M505	1950	3050

Table II. - continued

Graph Number	Altitude Ft/Meters	Drag Curve	Weight Grains	Muzzle Velocity fps/mps
20	7000	M505	2100	2850
		M505	1950	3050
		M505	1950	2950
21	7000	M505(M56)	1540	3350/1021.08
		M505	2100	2850
		SAPI	2100	2850
22	6000	M505(M56)	1540	3350
		M505	2100	2850
		SAPI	2100	2850
23	7000	SAPI	1950	2950
		M505	1950	2950
		SAPI	2100	2850
		M505	2100	2850
		M505(M56)	1540	3350
24	6000	M505(M56)	1540	3350
		M505	2100	2850
		SAPI	2100	2850
		M505	1950	2950
		SAPI	1950	2950
25	6000	M505(M56)	1540	3350
		M505	2100	2850
		SAPI	2100	2850
	6000	M505	1950	3050
		SAPI	1950	3050
26	7000	SAPI	1950	3050
		M505	1950	3050
		SAPI	2100	2850
		M505	2100	2850
		M505(M56)	1540	3350
27	6000	M505(M56)	1540	3350
		API	2500	2650/807.72
		SAPI	2100	2850
		M505	1875	3016
		SAPI	1875	3016

*NOTE I: The M505 Drag curve was obtained from Ballistic Research Laboratory, Aberdeen, Md and SAPI drag curve was obtained from 20mm API and SAPI Design Review Memorandum, Phase I, October 28, 1969, by AVCO Corporation Ordnance Division.

TABLE III.
20MM PROJECTILES
AIR TO GROUND TRAJECTORIES

Drag Curve used	Weight grains	Muzzle Velocity fps/mps
M53	1540	3100/944.88
SAPI	2100	2450/746.36
SAPI	2500	2150/655.32
M505	2100	2450/746.36

Graph Number	Altitude feet/meters	Helicopter Velocity knots/fps/mps	Descent Angle
28	200/60.96	0.0	5°
29	1000/304.8	0.0	5°
30	200	0.0	10°
31	1000	0.0	10°
32	200	0.0	15°
33	1000	0.0	15°
34	200	0.0	30°
35	1000	0.0	30°
36	200	0.0	45°
37	1000	0.0	45°
38	200	50.0/84.45/57.58	5°
39	1000	50.0	5°
40	200	50.0	10°
41	1000	50.0	10°
42	200	50.0	15°
43	1000	50.0	15°
44	200	50.0	30°
45	1000	50.0	30°
46	200	50.0	45°
47	1000	50.0	45°
48	200	100.0/168.89/115.16	5°
49	1000	100.0	5°
50	200	100.0	10°
51	1000	100.0	10°
52	200	100.0	15°
53	1000	100.0	15°

TABLE III. - continued

Graph Number	Altitude feet/meters	Helicopter Velocity knots/fps/mps	Descent Angle
54	200	100.0	30°
55	1000	100.0	30°
56	200	100.0	45°
57	1000	100.0	45°
58	200	150.0/253.34/172.73	5°
59	1000	150.0	5°
60	200	150.0	10°
61	1000	150.0	10°
62	200	150.0	15°
63	1000	150.0	15°
64	200	150.0	30°
65	1000	150.0	30°
66	200	150.0	45°
67	1000	150.0	45°
68	200	200.0/337.79/230.31	5°
69	1000	200.0	5°
70	200	200.0	10°
71	1000	200.0	10°
72	200	200.0	15°
73	1000	200.0	15°
74	200	200.0	30°
75	1000	200.0	30°
76	1000	200.0	45°

TABLE IV.
20 MM PORJECTILES
GROUND TO GROUND TRAJECTORIES*

Graph Number	Drag Curve	Weight Grains	Muzzle Velocity fps/mps
77 - 88	M505 (M56)	1540	3350/1021.08
	M505	1950	2950/899.16
	SAPI	1950	2950/899.16
89 - 100	M505 (M56)	1540	3350/1021.08
	M505	1950	3050/929.64
	SAPI	1950	3050/929.64

*ANGLES OF ELEVATION: 3^{o}, 6^{o}, 9^{o}, 12^{o}, 15^{o}, 18^{o}, 21^{o}, 24^{o}, 27^{o}, 30^{o}, 45^{o}, 60^{o}

TABLE V.
CALIBER .50 PROJECTILES
GROUND TO GROUND TRAJECTORIES*

Graph Number	Drag Curve	Weight Grains	Muzzle Velocity fps/mps
101 - 120	M2	1033.	2488/758.34
	M2	850.	2910/886.97
	M2	662.	2600/792.48
121 - 140	M8	662.	2910/886.97
	M8	850.	2600/792.48
	M8	1130.	2488/758.34

*ANGLES OF ELEVATION: 1^{o}, 2^{o}, 2.5^{o}, 3^{o} thru 16^{o}, 30^{o}, 45^{o}, 60^{o}

CONCLUSIONS

This report covers a wide range of combinations of drag curve, projectile weight, and muzzle velocities. These parameters in turn effect the time of flight and maximum range of the performance of the various projectiles. It is recommended that similar trajectories be generated for an air to air role as well as other ammunition.

REFERENCES

1. U.S. Army Weapons Command, "Some Mathematical Models and Computer Programs for Small Arms Analyses," SY-TN10-80, Ad Hoc Small Arms Systems Analyses Working Group.

2. Ballistic Research Laboratories, "Aerodynamic Data for Spinning Projectiles" Report No. 620, H. P. Hitchcock October 1947.

3. Engineering Design Handbook, "Design for Control of Projectile Flight Characteristics" AMCP-706-242, Sept 1966.

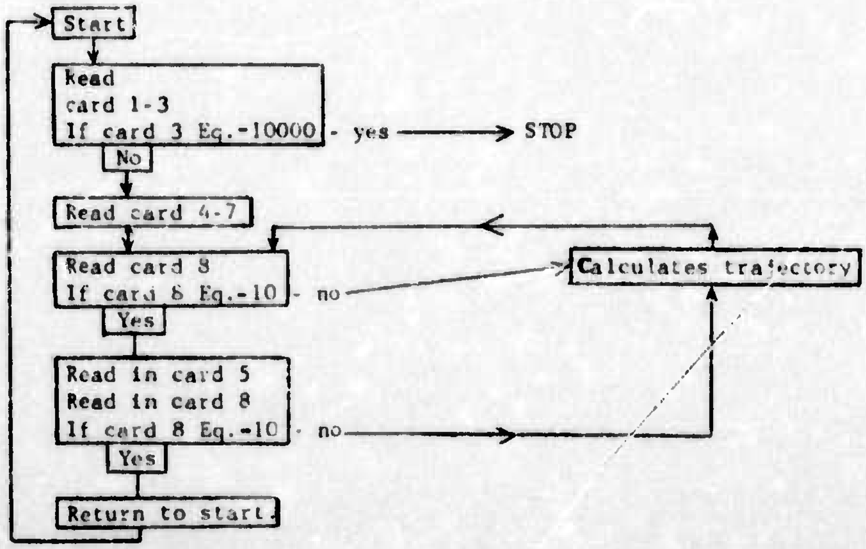
4. BRL Report No. 1628, "Comparative Evaluation of 20 mm Developmental Ammunition (U)", Edited by George Samos, December 1972.

APPENDIX A

TRAJE DATA INPUT AND FLOW CHART

CARD TYPE	COLUMNS	FORMAT	SYMBOL	IDENTIFICATION	UNITS
1	1 - 7	F7.4	P	pressure	cm hg
	8 - 14	F7.4	TEMP	temperature	°F
2	1 - 24	6A4	SHAPE	projectile shape	
3*	1 - 6	F6.3	V (1)	velocity	
	7 - 14	F8.5	CD(1)	drag coefficient	
4	1 - 7	F7.2	DVV	velocity	interval
5	1 7	F7.2	Y(1)	altitude	meters
6	1 - 10	F10.5	G	gravity	m/sec
	11 - 20	F10.5	A	cross sectional area	in^2
	21 30	F10.5	XM	mass	grains
	31 - 40	F10.5	ANGO	angel of descent or ascent	radians
	41 - 50	F10.5	VI	muzzle velocity	fps
7	1 - 7	F7.4	W	wind velocity	mps
8	1 - 6	F6.2	VPLANE	aircraft velocity	fps

FLOW CHART



* Note: card type 3 is a set of cards containing the points of the drag curve with the last card being -10.

APPENDIX B

COMPUTER PROGRAM LISTING

```
      PROGRAM TRAJE(INPUT,OUTPUT,TAPE1=INPUT,TAPE3=OUTPUT,TAPE4)
      REAL LOT
      DIMENSION SHAPE(6)
      DIMENSIONANGA(200),CO(200),VELDA(200)
      COMMON Y(200),T(200),V(200),CD(200),K,I,X(200)
      COMMON VV(200),CC(200),VPLANE
      COMMON ZZ(200)
    5 FORMAT(6A4)
    6 FORMAT (20X, 19H MUZZLE VELOCITY =  , F5.0, 7H FT/SEC  )
    7 FORMAT ( 1H , 2A7)
    8 FORMAT (2F5.2)
    9 FORMAT (2A5)
   25 FORMAT (1H1, 10X, 70H ANGO (MILS), D(LBS/FT3), PRES (IN), TEMP (F)
     A XM  (GRAINS) V1(FT/SEC)          )
   27 FORMAT( 25H WIND VELOCITY (M/SEC) = , F7.4, 12H PRESSURE = ,F7.4,
     218H TEMPERATURE(F) = , F7.4)
   44 FORMAT(10X, 10H Y(METERS), 9X,11H X(METERS), 13X, 7H T(SEC), 6X, 1
     24H V(METERS/SEC), 16X, 4H CD , 9X, 11H Z(METERS) )
   45 FORMAT(1X,3F20.8)
   46 FORMAT(1X,10H ALTITUDE ,10X,  9H DENSITY , 11X, 13H TEMPERATURE ,7
     2X)
   55 FORMAT( 5F20.8)
   56 FORMAT(5F16.8)
   57 FORMAT(100X,3F10.4)
   58 FORMAT(1X,6F20.8)
   60 FORMAT(11H DENSITY = ,F7.6, 8H TEMP = ,F10.4,10H HEIGHT = ,F10.4)
   61 FORMAT (1H1)
   68 FORMAT(5F10.5)
   69 FORMAT( 15X, 4E15.8)
   75 FORMAT( 14H FORCE (NTS) =,E16.6, 15H YDOT (M/SEC) =,E16.6, 16H VEL
     2   (M/SEC) = ,E16.6)
   80 FORMAT(14H VEL(M/SEC) = , 14X , 7H CD  = , 20X)
   81 FORMAT(I7,4F15.8)
  102 FORMAT (15F5.0)
  103 FORMAT (1H1, 61A1)
  106 FORMAT(F7.2)
  202 FORMAT(2F20.8)
  203 FORMAT(F6.2)
  204 FORMAT(F6.3,F8.5)
  206 FORMAT(3F7.4)
  428 FORMAT (18H PLANE VELOCITY =, F6.0,34H FT/ SEC AT AN ANGLE OF DESC
     1ENT OF , F6.4, 9H RADIANS.)
  528 FORMAT(46H INPUT IS REL PROJ VEL IN FT/SEC,DRAG COEF KD.)
 1000 FORMAT (3A1)
 1010 FORMAT( 11H WT OF PROJ,F14.8, 11H NOSE SHAPE,A5)
 1011 FORMAT(13H MUZZLE VEL= , E14.7,  8H FT/SEC )
 1012 FORMAT(1X,6A4)
 1013 FORMAT(1X,E14.8,19H WT. OF PROJECTILE )
C***********        DATA INPUT       *****************
C    1 PRESSURE,TEMPERATURE   (2F7.4)
C    2 SHAPE   (6A4)
C********      3     VV(J)(FT/SEC),CC(J)(KD)          F6.3,F8.5)
C     4       DVV(INCREMENTS/VELOCITY)           (F7.2)
C     5        Y(1)(ALTITUDE)            (F7.2)
C     6       G(GRAVITY-METERS PER SECONDS SQUARED ,A(CROSSSECTIONAL AREA)
C       ,XM(MASS-GRAINS), ANGO(ANGLE OF DESCENT  OR ASCENT,V1(MUZZLE
C    7 WIND VELOCITY   (F7.4)
C    8 AIRCRAFT VELOCITY (F6.2)
C     9 ALTIUDE  ** FOR SAME AIRCRAFT VELOCITIES CAN RUN AT VARIOUS ALTI-
C                 TUDES, TO CHANGE AIRCRAFT VELOCITY PUT -10. FOLLOW
C                 WITH ALTITUDE AND THEN AIRCRAFT VELOCITY WILL RETURN
C                 ASKING FOR ALTITUDE AGAIN **
C    10 -10. PLACED FOR LAST AIRCRAFT VELOCITY, -10. PLACED FOR LAST G
C N=NUMBER OF TIME INTERVALS
```

```
C DT=TIME INCREMENTS (SEC)
C VELDY=DECREASE IN VELOCITY DUE TO DRAG/DRAG VEL IN Y DIRECTION (M/SEC)
C AV=AVERAGE DECELERATION (VEL) DUE TO DRAG (M/SEC)
C***************          ATMSI    =     F00I0
C       ATMSI(YH=ALTITUDE(FEET), TEMP(RANKINE),PRES (SLUG/FT**2,
C DENSITY= SLUG/FT**3)
C   A=  CROSS-SECTIONAL AREA FOR 20MM  (EITHER .515  OR     PI*R*R)
C C=CONSTANT
C ANG= ANGLE OF TRAJECTORY , YDOT= Y VELOCITY ,DX=CHANGE IN X DISTANCE
C X(I)=X DISTANCE , AV = AVERAGE VELOCITY , Y(I)= Y DISTANCE
C VEL= FT/SEC     ,KD          DRAG CURVE
C   7  IS  WIND VELOCITY EFFECT ON PROJECTILE
C**      TEMPERATURE IN F
C**  PRESSURE CM OF MERCURY
C****  W= WIND VELOCITY IN METERS PER SECOND
C**  IF VELOCITY(FPS) AND KD CURVE
C**  VV(J)=VV(J)/3.2809
C**   20I CC(J)=CC(J)*8./3.14159
C**  IF INPUT VELOCITY(MACH)  AND CD CURVE
C*    SPSO=SQRT((459.67   +   TEMP)/518.67)*340.294
C**   VV(J)=VV(J)*SPSO
C**  201  CONTINUE
      IN=I
      IO=3
    2 CONTINUE
      READ(IN,206)P,TEMP
      READ(IN,5)SHAPE
      SPSO=SQRT((459.67   +   TEMP)/518.67)*340.294
      DO 201 J=I,200
      READ(IN,204)VV(J),CC(J)
      IF(VV(J).LE.- 9.)GOTO228
      IF(VV(J).GE.I0000.)GOTO40
      VV(J)=VV(J)*SPSO
  20I CONTINUE
  228 M=J-I
      DV=VV(I)
      N=VV(I)/I0.
      K=I
      DO20J=2,N
      DV=DV-I0.
      CALL INTERR(CC,CD(J),DV,VV,K)
      V(J)=DV
   20 CONTINUE
      V(I)=VV(I).
      CD(I)=CC(I)
      WRITE(IO,25)
      KKK=0
      DO 1001 J=I,N
      VV(J)=V(J)
      CC(J)=CD(J)
 100I CONTINUE
      READ(IN,I06)DVV
   21 CONTINUE
      READ(IN,106) Y(1)
      IF(Y(1).LE.-I0.)GOTO17
      GOTO18
   I7 CONTINUE
      READ(IN,106) Y(1)
      READ(IN,203) VPLANE
      IF(VPLANE.LE.-I0.)GOTOI9
   I8 CONTINUE
      IF(KKK.GE.1)GOTO24
   I9 READ(IN,68)G,A,XM,ANGO,VI
      IF(G.LE.-I0.)GOTO2
      READ(IN,206)W
      WRITE(IO,27)W,P,TEMP
```

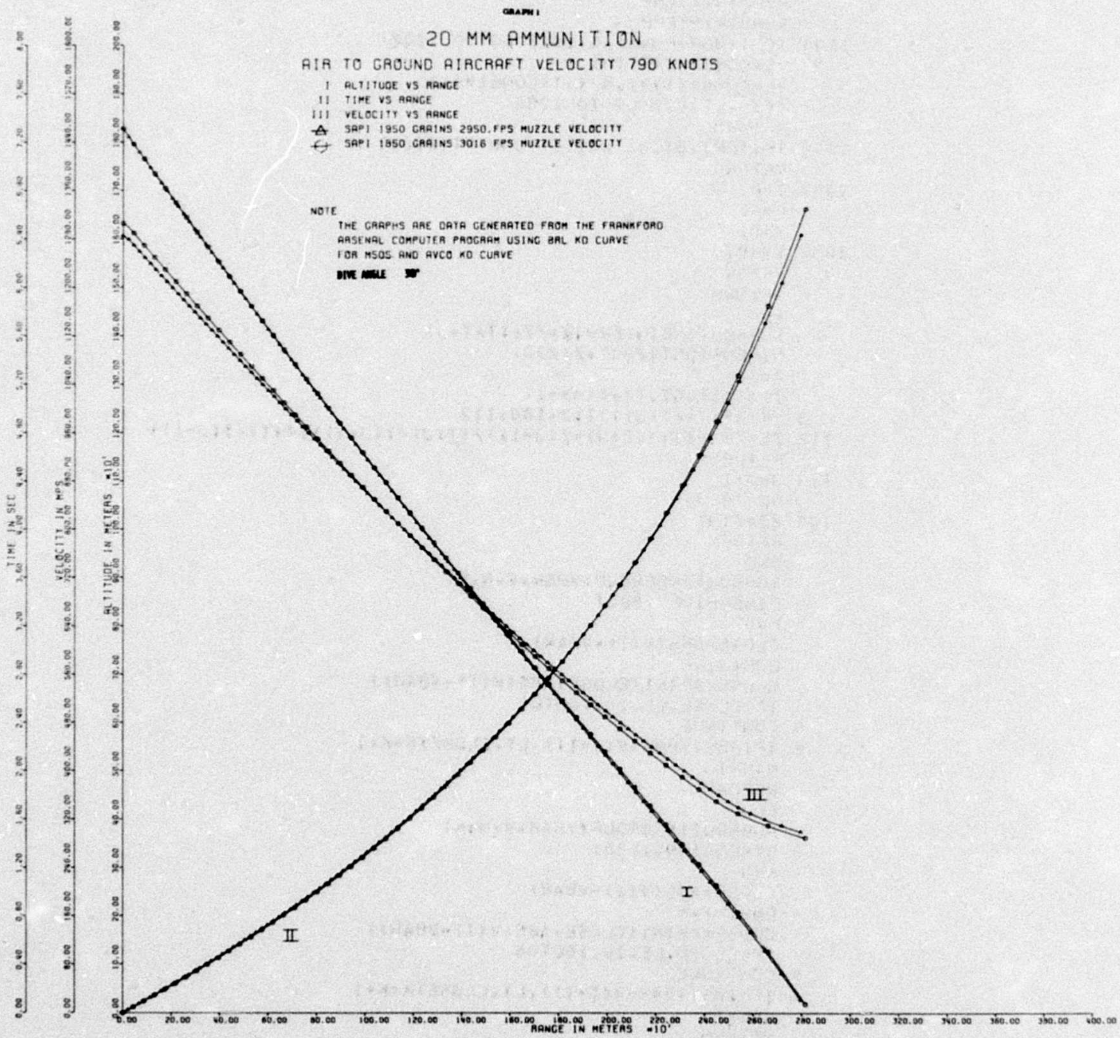
```
      WRITE(10,1012)SHAPE
      WRITE(10,1013)XM
      VMUZ = VI
      XM = XM/7000.
      ANGO = ANGO * .001
      WRITE(10,1011)VI
   26 READ(1N,203)VPLANE
   24 CONTINUE
      WRITE (10,428) VPLANE , ANGO
      VI=VMUZ
      VI =(VI + VPLANE)/3.2808
      CALLGROUP(VI,VV,N,1)
      K=N-1+1
      DO 328 J = I,K
      L=1+J-I
      CD(J)=CC(L)
  328 V(J)=VV(L)
   28 VELDY = 0.
      V(1) = VI
      T(1) = 0.
      X(1)=0.
      ANG = ANGO
      KI=V(I)/I0.
      DVI=DVV/10.
      IDV=DVI
      K=1
      C2=1.64*A/144./XM
      VDI=0.
      DV=DVV
      ZDI=0.
      ZZ(1)=0.
      Z=0.
      DO131=2,KI
      XI=I-1
      K=K+IDV
      KK=K-IDV
   30 YH=3.281*Y(I-1)
      IF(YH.LE.0.)GOTO31
      CALLFOOID(YH,TEMP,PRES,D,VIS,VELA,0)
      GOTO32
   31 D=.00237
   32 D=32.1739*D
      TEMP=TEMP - 459.69
      C=C2*D
      VBAR=(V(I) + V(I-1))*.5
      ANGI=ANG
      ANG=ANG-.0005
      IF(ANG.LT.-1.5)GOTO40
  221 CONTINUE
      DT=2.*(1./(V(I)-XI*DV)-1./(V(I)-(XI-1.1*DV))/C/(CD(I)+CD(I-1))
      DT= DT + 2./C/(CD(I) + CD(I-1))*ALOG(COS(ANGI)/COS(ANG))/VBAR
      AV=.5*(CD(I)*(V(I) - XI*DV)**2*SIN(ANG) + CD(I-1)*(V(I) - (X
     2I-1.0)*DV)**2*SIN( ANGI))
      T(I)=T(I-1) + DT
      VELDY= VDI + C*AV*DT/2.
      ANG2=ANG
      YDOT= -VELDY -G*T(I) + V(I)*SIN(ANGO) - C*AV*DT/2.
      ANG=ATAN(YDOT/(V(I)-XI*DV)/COS(ANG))
      IF(ABS(ANG2 - ANG) .LE. .001*ABS(ANG))GOTO224
      GOTO221
  224 VDI= VELDY + C*AV*DT/2.
  222 CONTINUE
      DX= 2.*((V(I) -(XI - I.1*DV)*COS(ANGI) - (V(I) - XI*DV)*COS(ANG))/
     2C/((CD(I)*(V(I) - XI*DV)) + (CD(I-1)*(V(I) - (XI-1.)*DV)))
      X(I)=DX + X(I-1)
      Y(I)=Y(I-1) - .5*(G*(T(I) + T(I-1)))*DT - VELDY*DT +DT*V(I)*SIN(A
```

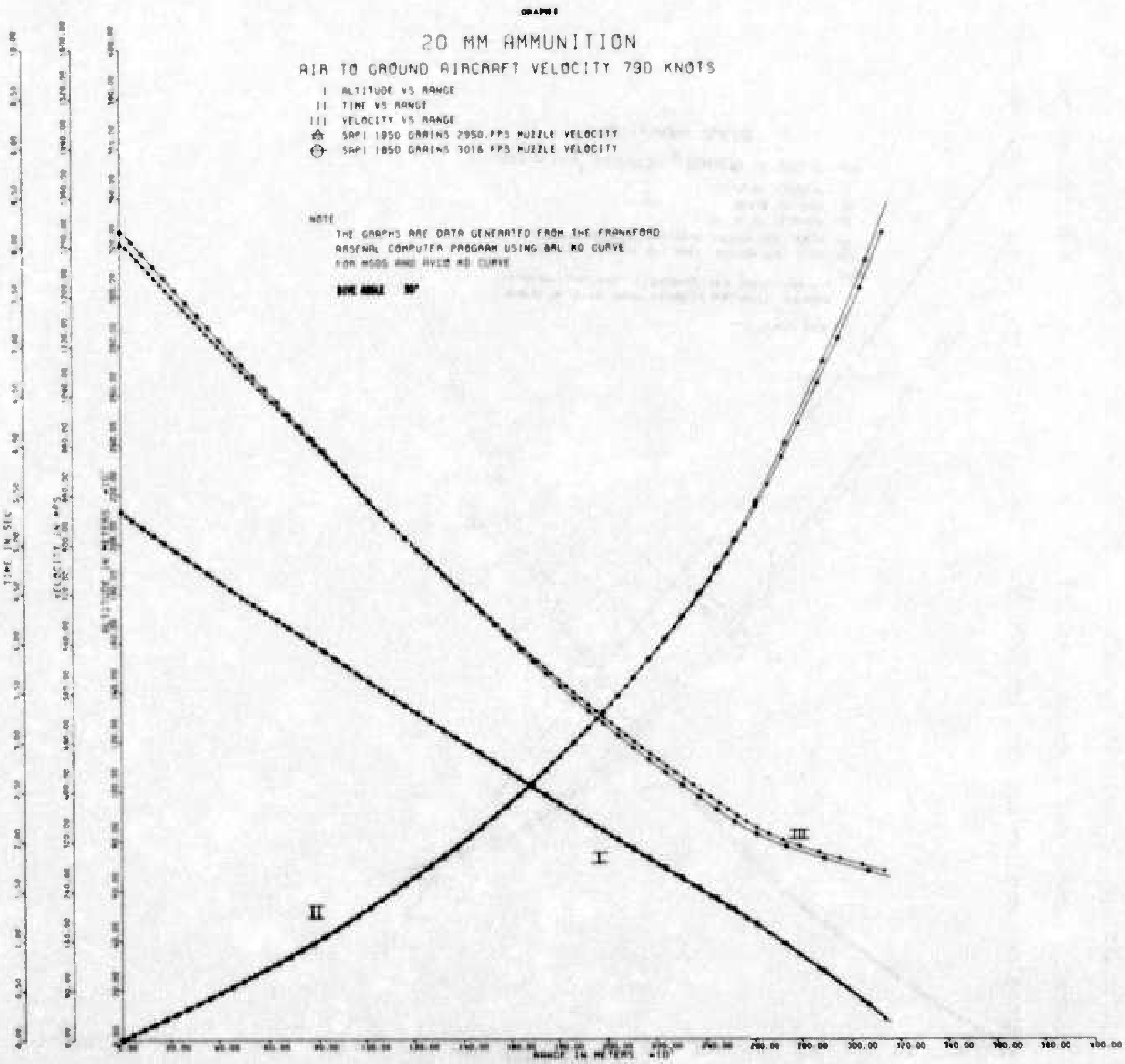
```
      2NG0)
       CBAR= C*(CD(I)*(V(I)-XI*DV)  +  CD(I-1)*(V(I) - (XI-1.)*DV))*2.25
       ZD=  W+ (ZD1 - W)*EXP(-CBAR*DT)
       Z= Z  +  W*DT  +  (ZD1 - W)/CBAR*(1.-EXP(-CBAR*DT))
       ZD1=ZD
       ZZ(I)=Z
       ANGA(I)=ANG
       CO(I)=C
       VELDA(I)=VELDY
       IF(Y(I))11,12,12
    12 IF(V(I).LE.0.)GOTO11
       IF(I.GE.200)GOTO11
    13 CONTINUE
    11 WRITE(10,44)
       I=I-1
       DO10J=1,I
       WRITE(10,58) Y(J),X(J),T(J),V(J),CD(J),ZZ(J)
    10 CONTINUE
       KKK=KKK+1
       GOTO21
    40 STOP
       END
       SUBROUTINE F001D (H,T,P,R,VK,VS,IDPT)
C      F001D  WAS PREVIOUSLY  ATMS1
       DIMENSION HH(12),W1(11),W2(11),W3(11),TB(11),PB(11),RB(11)
       DIMENSION A(3),B(3),C(3),D(3)
   350 FORMAT(51H0112547537990105160170200700-225569-525612000157689,/
      162H13846611388300012086 9-159202-7592180002062342414588541208 86289,
      260H170824075434134164803507156832960222129976137005186882116217,/
      357H23769238998847273070623899880519797765508738000 2515528804,
      426H508788000121811394682981 88, /
      561H21084118924818821809426140618815562223223861887578184525661 88,
      660H5895413382836188297596113304863567664902057622698 81987291000,/
      734H759511174164220025935787273966 1814)
   351 FORMAT(F1.0,-3P6F2.0,5F3.0, 10PF7.0, 5PF7.0,0P3F1.0, 9PF6.0,/
      1  10PF6.0, 4PF6.0,0P3F1.0, 9PF6.0, 10PF7.0, 5PF7.0,0P3F1.0, 9PF6.0
      2 , 10PF6.0, 4PF5.0,0PF1.0, 10PF6.0, 5PF6.0,0PF1.0, 11PF6.0, 5PF6.0
      3 ,0PF1.0, 11PF6.0, 5PF6.0,0PF1.0, 11PF6.0, 5PF6.0,0PF1.0,3P2F7.0,/
      4 8PF6.0,3P2F6.0,7PF4.0,3P2F6.0,8PF4.0,4P2F7.0,10PF5.0,
      5 4P2F7.0,11PF6.0,3PF6.0,/5PF4.0,12PF5.0,
      6 3PF6.0,7PF5.0,12PF4.0,3PF6.0,8PF5.0,13PF4.0,3PF7.0,9PF4.0,15PF4.0
      7 ,3PF7.0,10PF5.0,15PF4.0,3PF7.0,10PF5.0,16PF4.0,4PF4.0,0PF7.0,
      8 6PF8.0,13PF6.0,2PF5.0,-4PF1.0,0P4F1.0,/6P2F6.0,-3P2F3.0,6P2F6.0,
      9 -4P2F2.0)
   352 FORMAT (1X,F3.2,11F10.0,/22(1X,3E20.10/),F8.4,F10.0,F10.6,E20.8,
      1 F8.2,F10.0,/1X,4(F5.2)/1X,2F10.6,2F10.0,/1X,2F10.6,5X,2F10.0)
  2001 FORMAT(1X,5HALT= ,E9.4,12H BELOW LIMIT)
       IF(ITAPE.EQ.4)GO TO 5
       ITAPE=4
       REWIND ITAPE
       WRITE(ITAPE,350)
       REWIND ITAPE
       READ (ITAPE,351) (HB(I),I=1,12),(W1(I),W2(I),W3(I),I=1,11),(TB(I),
      1 PB(I),RB(I),I=1,11),CON1,CON2,CON3,CON4,CON5,CON6,(A(I),B(I),C(I)
      2 ,D(I),I=1,3)
     5 CONTINUE
       HGP=CON1*H/(1.+(CON1*H/CON2))
       IF(HGP.LT.0.) HGP=0.
       DO 1002 M=1,11
       IF(HGP-HB(M))1003,1004,1002
  1002 CONTINUE
       IF ((HGP-HB(12)).GT.0.) GO TO 1052
       M=12
  1003 M=M-1
  1004 TM=TB(M)*(1.+W1(M)*(HGP-HB(M)))
       IF ((HGP-90000.).GT.0.) GO TO 1006
```

```
      T=TM
      GO TO 1070
1006  IF ((HGP-180000.).GT.0.) GO TO 1009
      I=2
      GO TO 1007
1009  I=3
1007  T=TM*(A(I)-B(I)*ATAN((HGP-C(I))/D(I)))
1070  IF (W2(M))1011,1020,1011
1011  TEMP=1.+W1(M)*(HGP-HB(M))
      P=PB(M)/TEMP**W2(M)
      R=RB(M)/TEMP**(1.+W2(M))
      GO TO 1030
1020  TEMP=EXP(-W3(M)*(HGP-HB(M)))
      P=PB(M)*TEMP
      R=RB(M)*TEMP
1030  IF ((HGP-CON6).GT.0.) GO TO 1032
      VS=CON3*SQRT(TM)
      VK=CON4*(T**1.5/((T+CON5)*R))
      IF(H.LT.0.) GO TO 1050
      RETURN
1050  IF(IOPT.GT.0) WRITE (JOUTPT,2001) H
      RETURN
1052  T=0.
      P=0.
      R=0.
1032  VS=0.
      VK=0.
      RETURN
      END
      SUBROUTINEINTERR(Z,ZZ,TT,T,J)
      DIMENSIONT(200),Z(200)
      A=1.
      IF(T(1).GT.T(2))A=-1.
    3 IF(A*(TT-T(J)))112,100,113
  112 ZZ=Z(J-1)+((Z(J)-Z(J-1))/(T(J)-T(J-1)))*(TT-T(J-1))
      RETURN
  113 J=J+1
      GO TO 3
  100 ZZ=Z(J)
      RETURN
      END
      SUBROUTINEGROUP(VBAR,V,N,K)
      DIMENSIONV(200)
      K=0
      CLOSE=ABS(V(1)-VBAR)
      DO5I=1,N
      CLOSE=AMIN1(CLOSE,ABS(V(I)-VBAR))
      IF(CLOSE.LE.10.)GOTO6
    5 CONTINUE
    6 IF(ABS(VBAR-V(I+1)).LT.CLOSE)K=K+1
      K=K+1
      RETURN
      END
      SUBROUTINEGROUP(VBAR,V,N,K)
      DIMENSIONV(200)
      K=0
      CLOSE=ABS(V(1)-VBAR)
      DO5I=1,N
      CLOSE=AMIN1(CLOSE,ABS(V(I)-VBAR))
      IF(CLOSE.LE.10.)GOTO6
    5 CONTINUE
    6 IF(ABS(VBAR-V(I+1)).LT.CLOSE)K=K+1
      K=K+1
      RETURN
      END
```

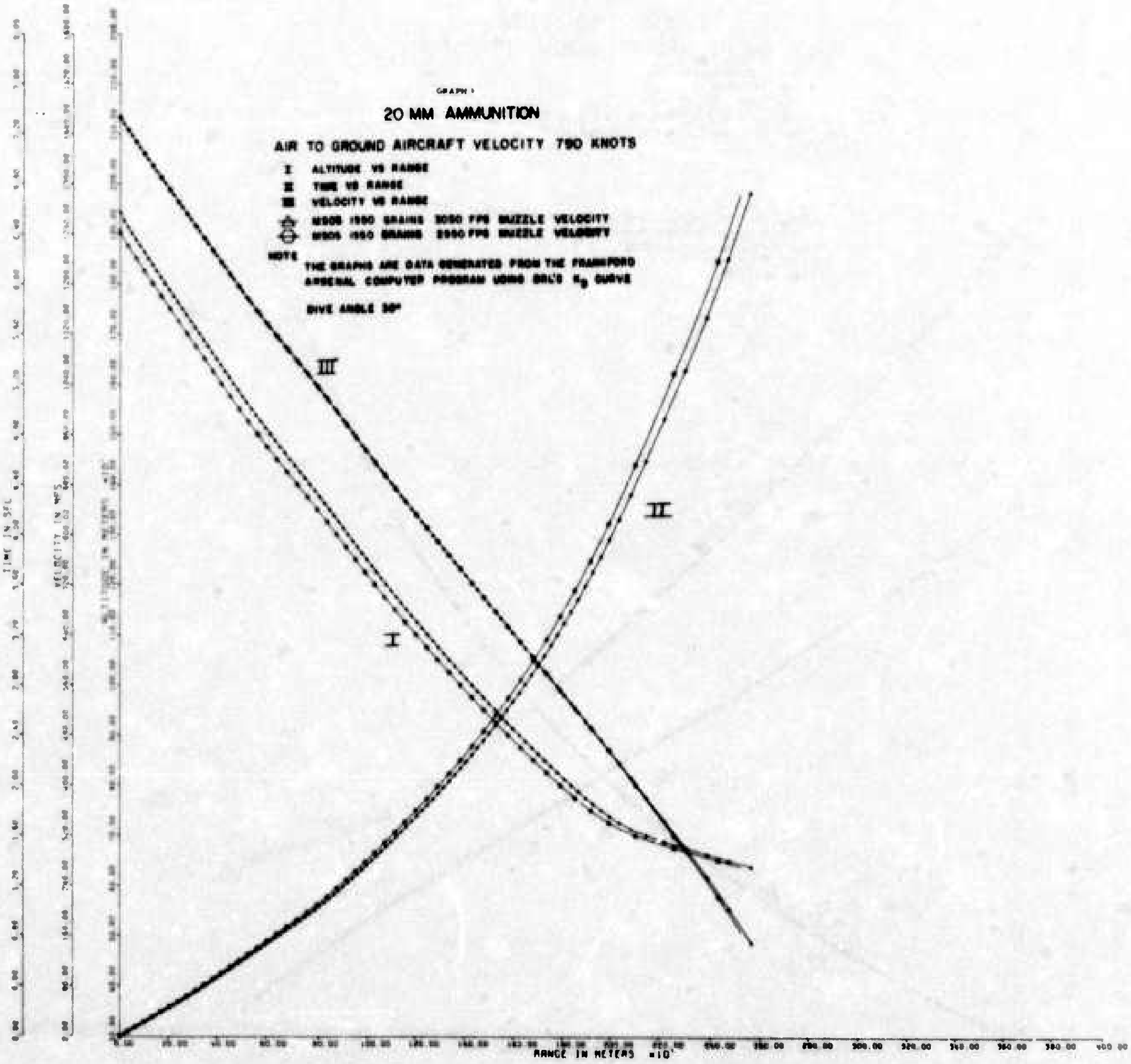
APPENDIX C

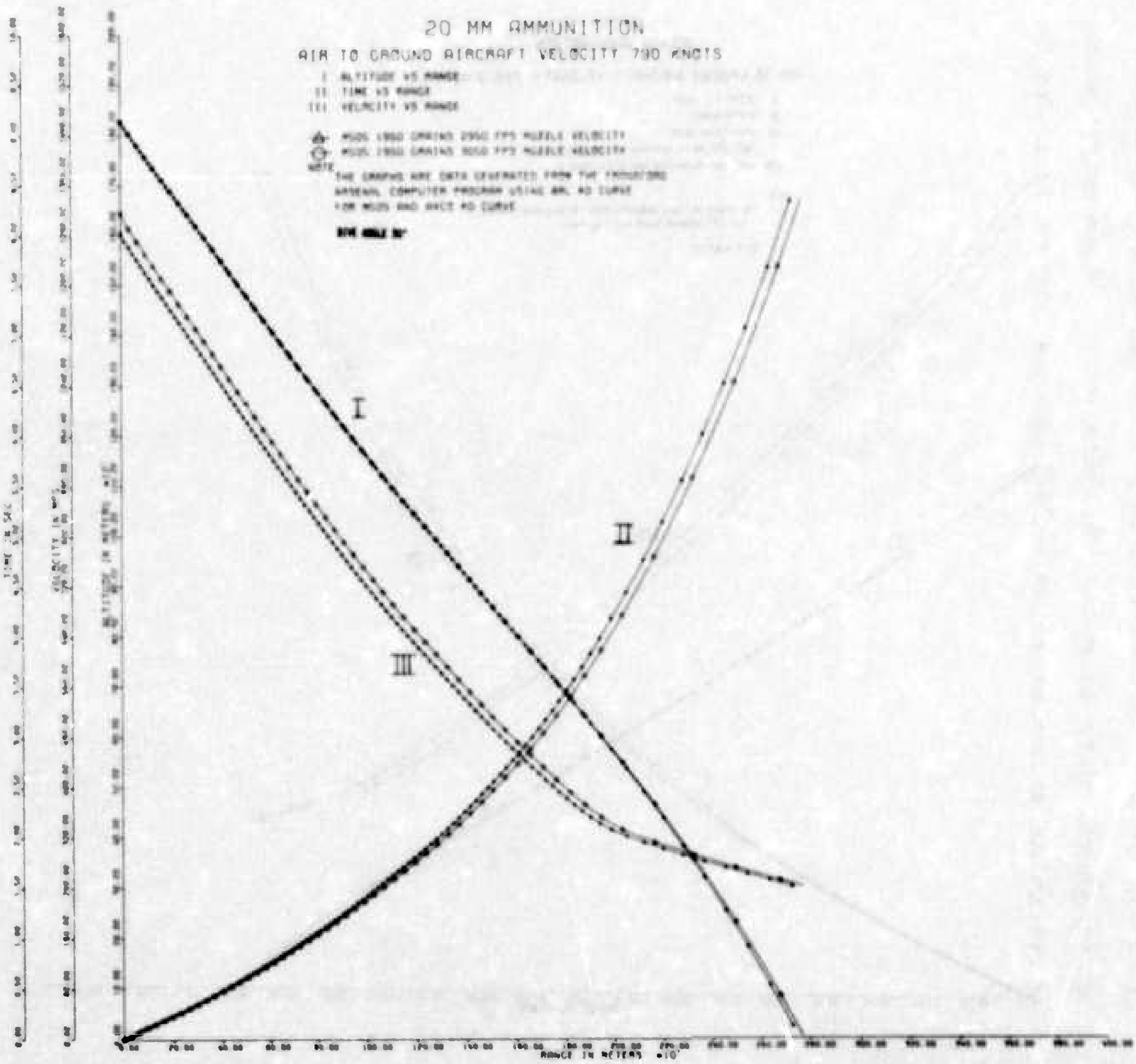
Graphs 1 to 140: 20MM and Caliber 50 Trajectories

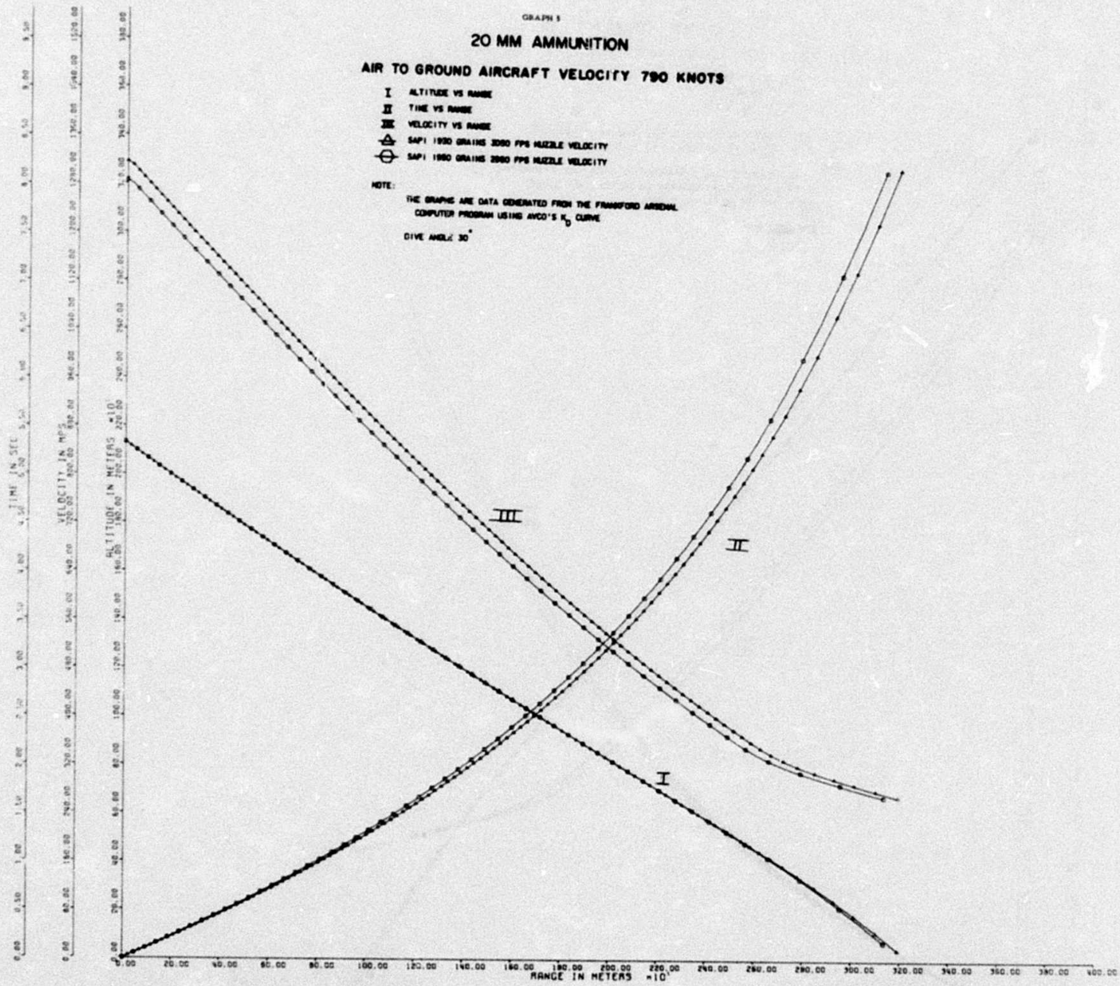


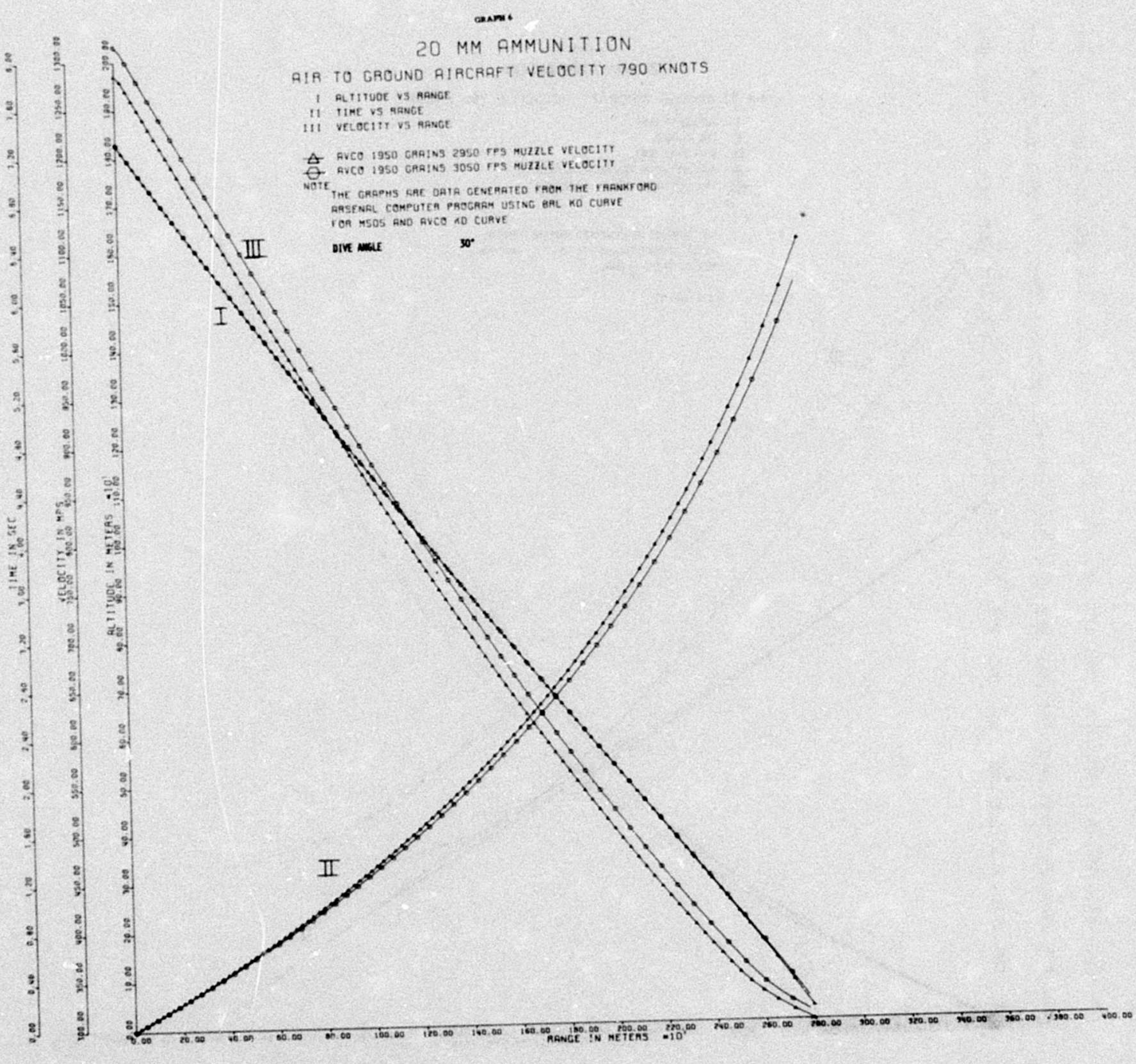


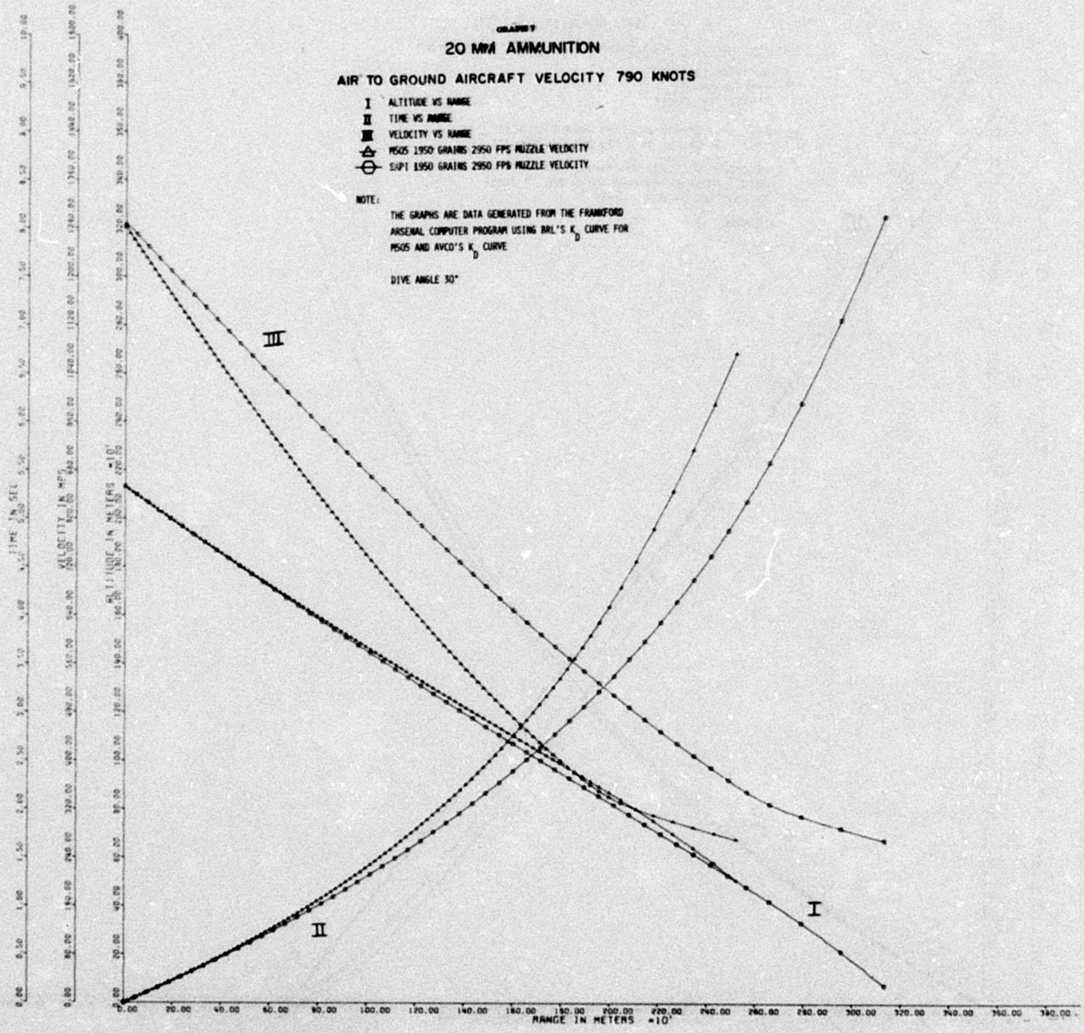
20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
SAPI 1850 GRAINS 2950 FPS MUZZLE VELOCITY
SAPI 1850 GRAINS 3018 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BAL KD CURVE
TIME IN SEC
RANGE IN METERS
I
II
III

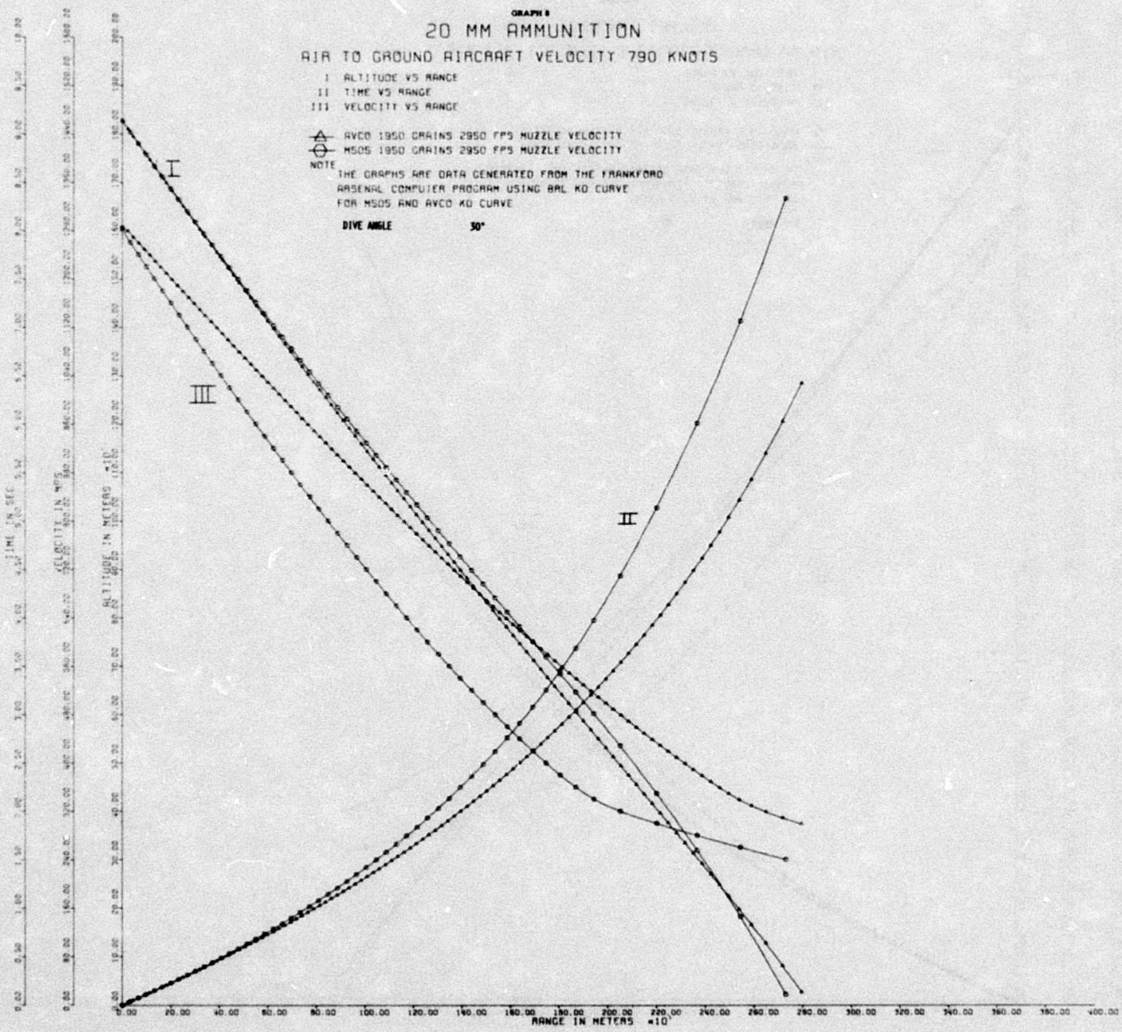

20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL'S CURVE
DIVE ANGLE 30°
III
I
II
TIME IN SEC
VELOCITY IN MPS
RANGE IN METERS *10

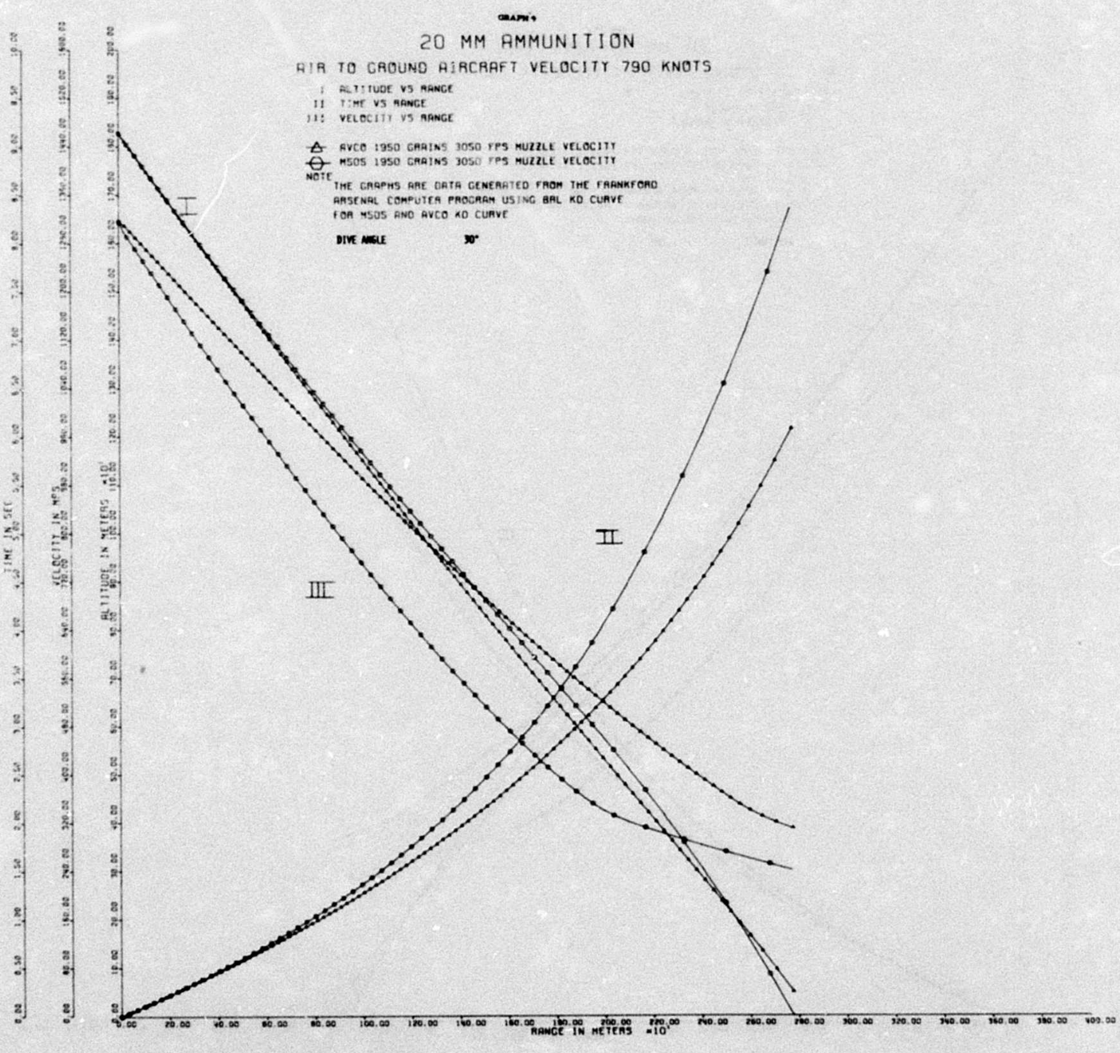

20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
I
II
III

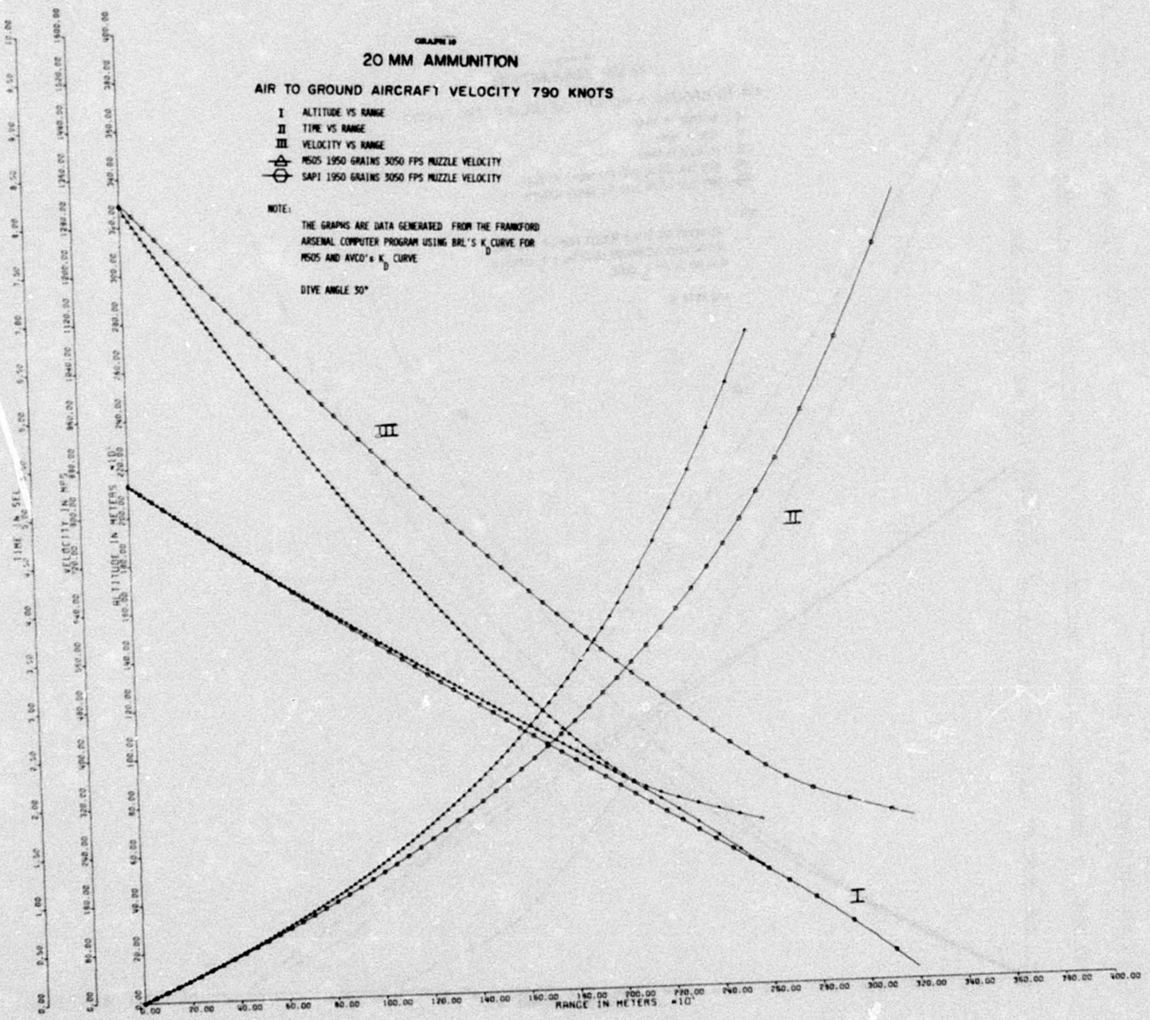

GRAPH 5
20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
SAPI 1930 GRAINS 3050 FPS MUZZLE VELOCITY
SAPI 1980 GRAINS 2980 FPS MUZZLE VELOCITY
NOTE:
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING AVCO'S K_D CURVE
DIVE ANGLE 30°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS ×10
RANGE IN METERS ×10
III
II
I

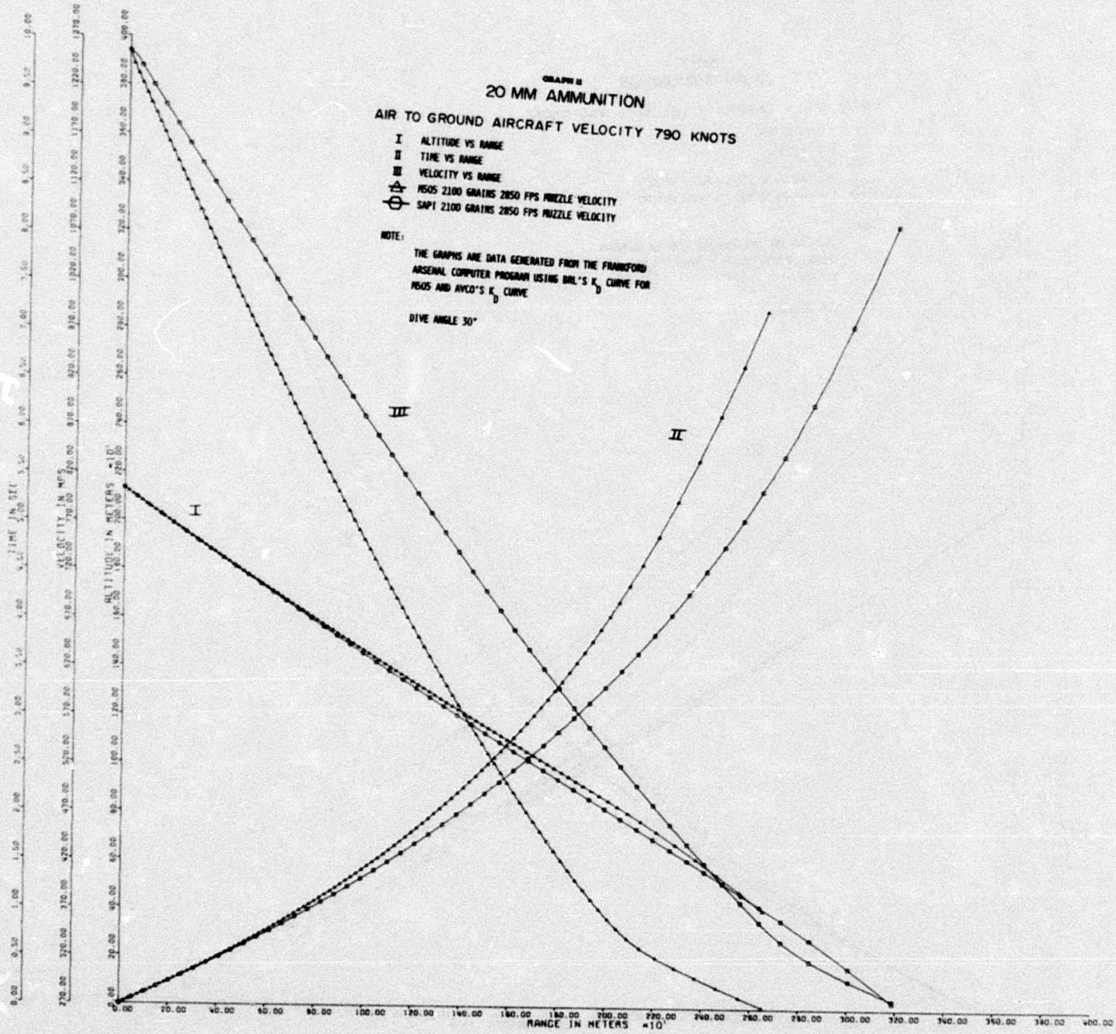

GRAPH 6
20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
AVCO 1950 GRAINS 2950 FPS MUZZLE VELOCITY
AVCO 1950 GRAINS 3050 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M505 AND AVCO KD CURVE
DIVE ANGLE 30°
I
II
III
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS

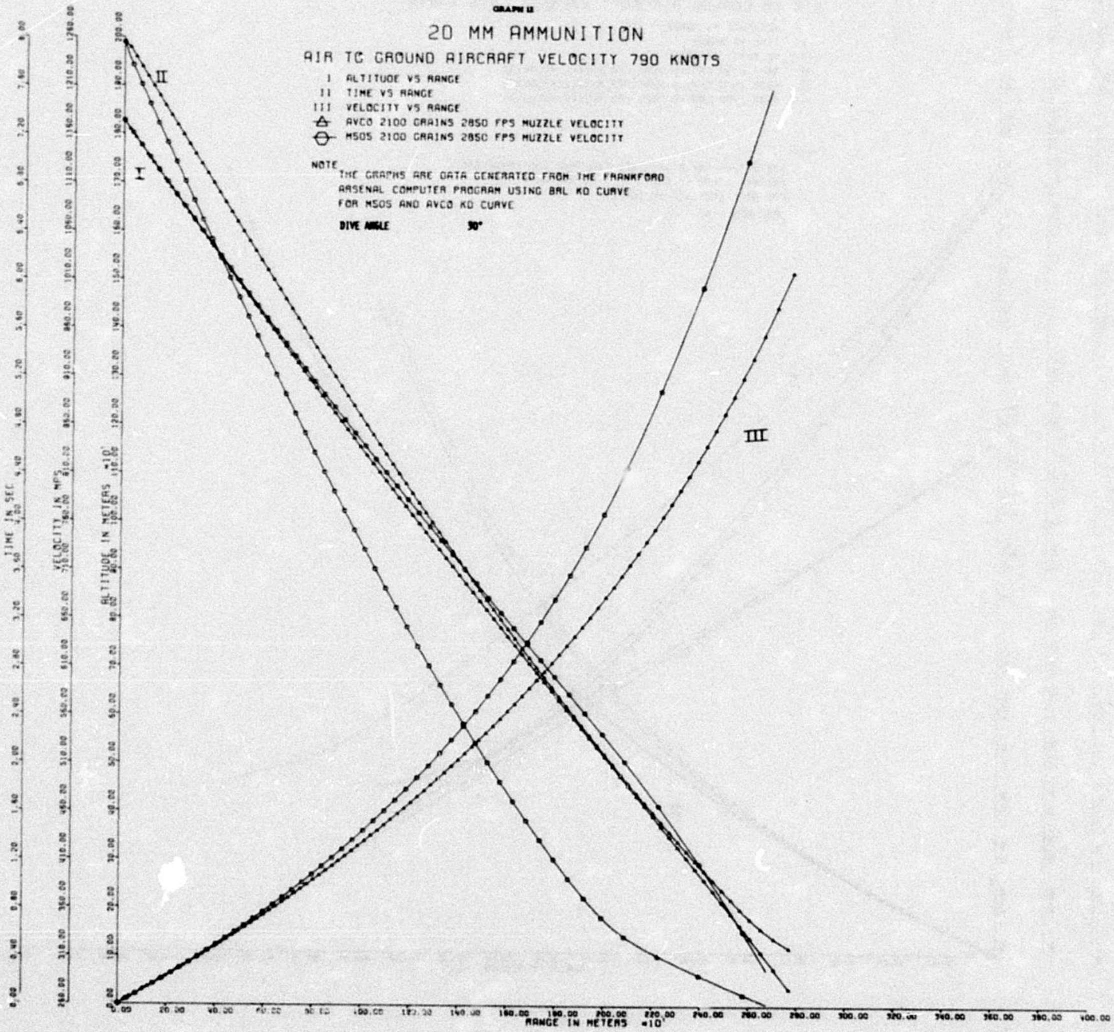

20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M505 1950 GRAINS 2950 FPS MUZZLE VELOCITY
SAPI 1950 GRAINS 2950 FPS MUZZLE VELOCITY
NOTE:
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL'S K_D CURVE FOR M505 AND AVCO'S K_D CURVE
DIVE ANGLE 30°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS
I
II
III

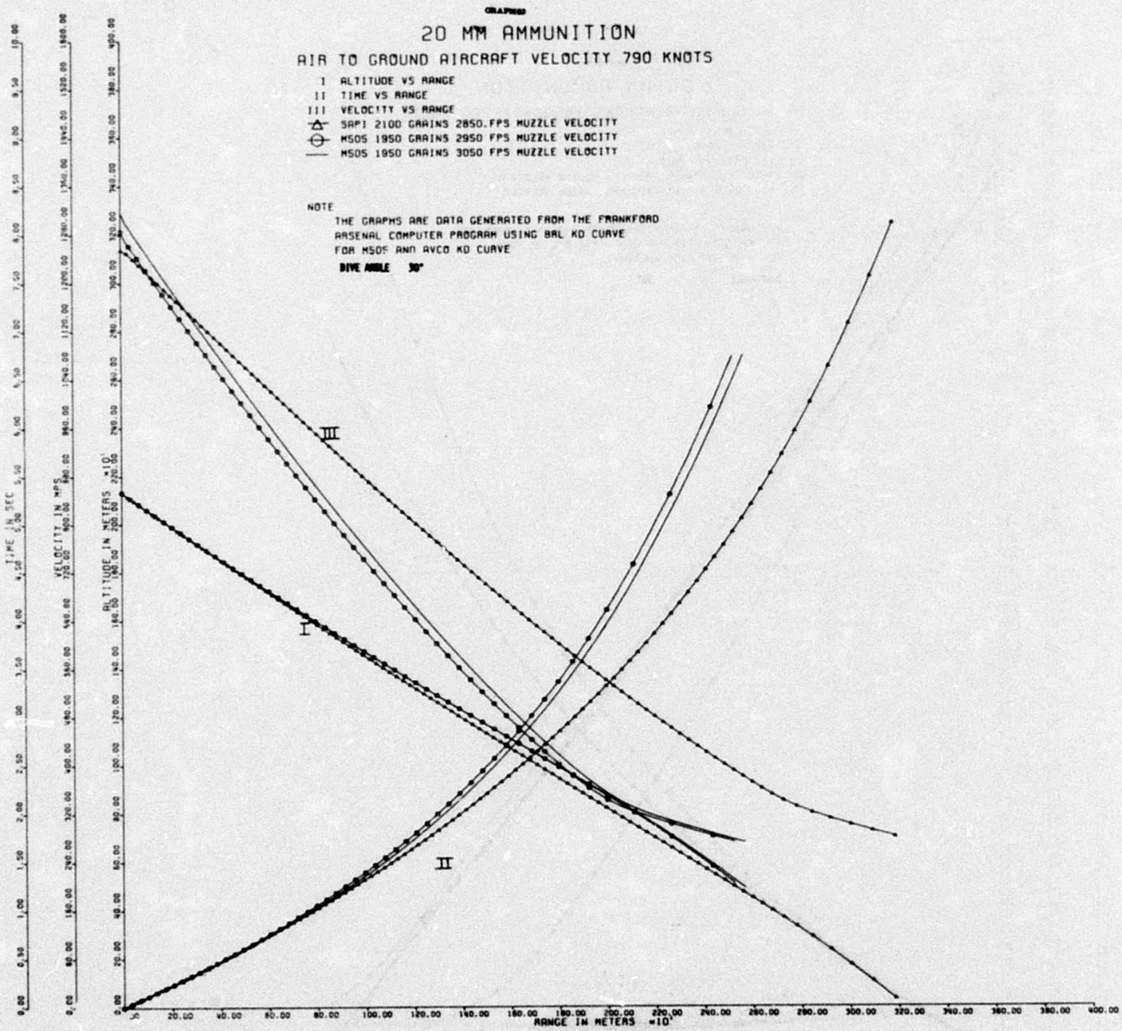

20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
AVCO 1950 GRAINS 2950 FPS MUZZLE VELOCITY
MSOS 1950 GRAINS 2950 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BAL KD CURVE FOR MSOS AND AVCO KD CURVE
DIVE ANGLE 30°
I
II
III
RANGE IN METERS

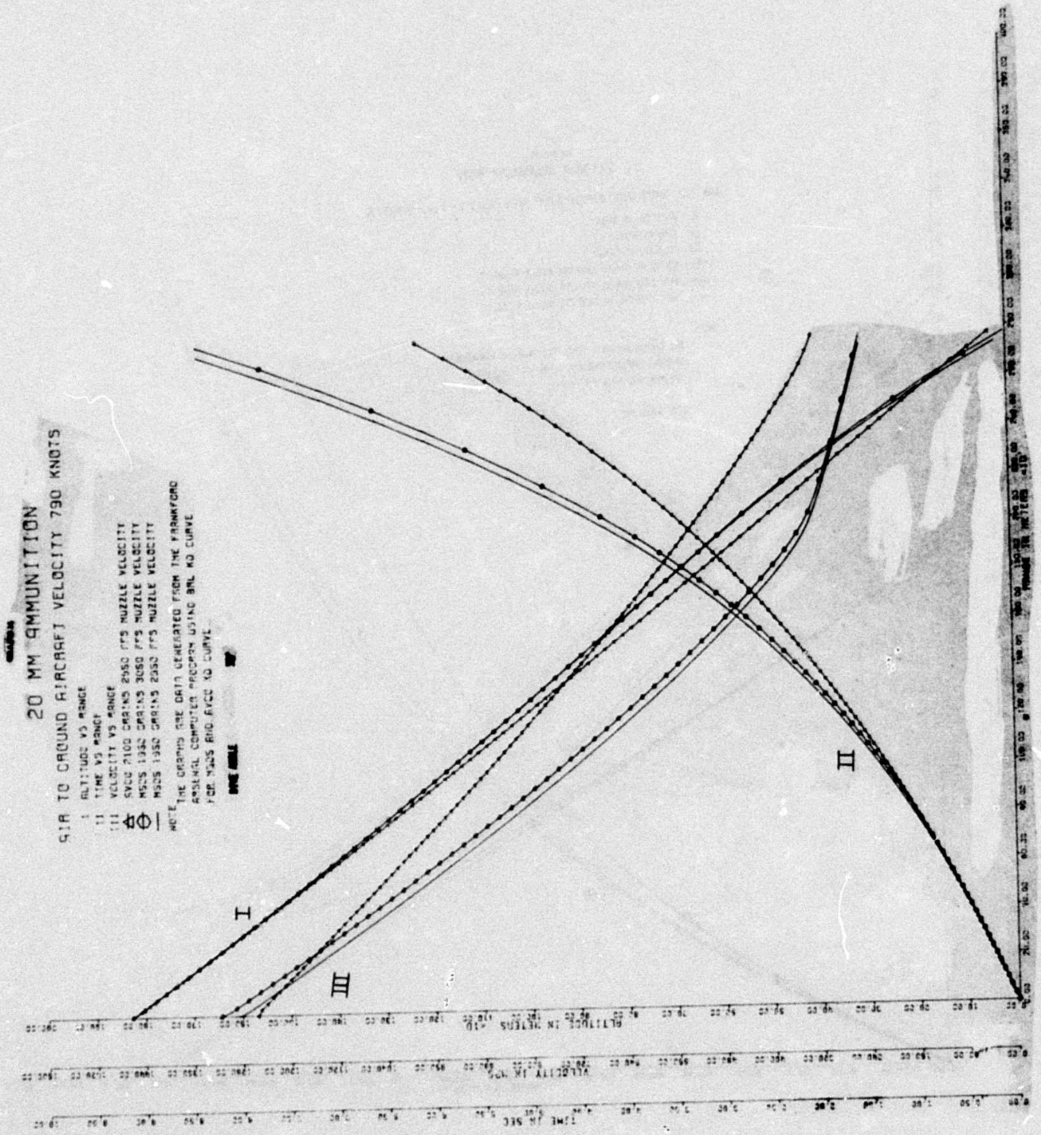

GRAPH 4
20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
AVCO 1950 GRAINS 3050 FPS MUZZLE VELOCITY
M505 1950 GRAINS 3050 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BAL KD CURVE FOR M505 AND AVCO KD CURVE
DIVE ANGLE 30°
I
II
III
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS ×10
RANGE IN METERS ×10

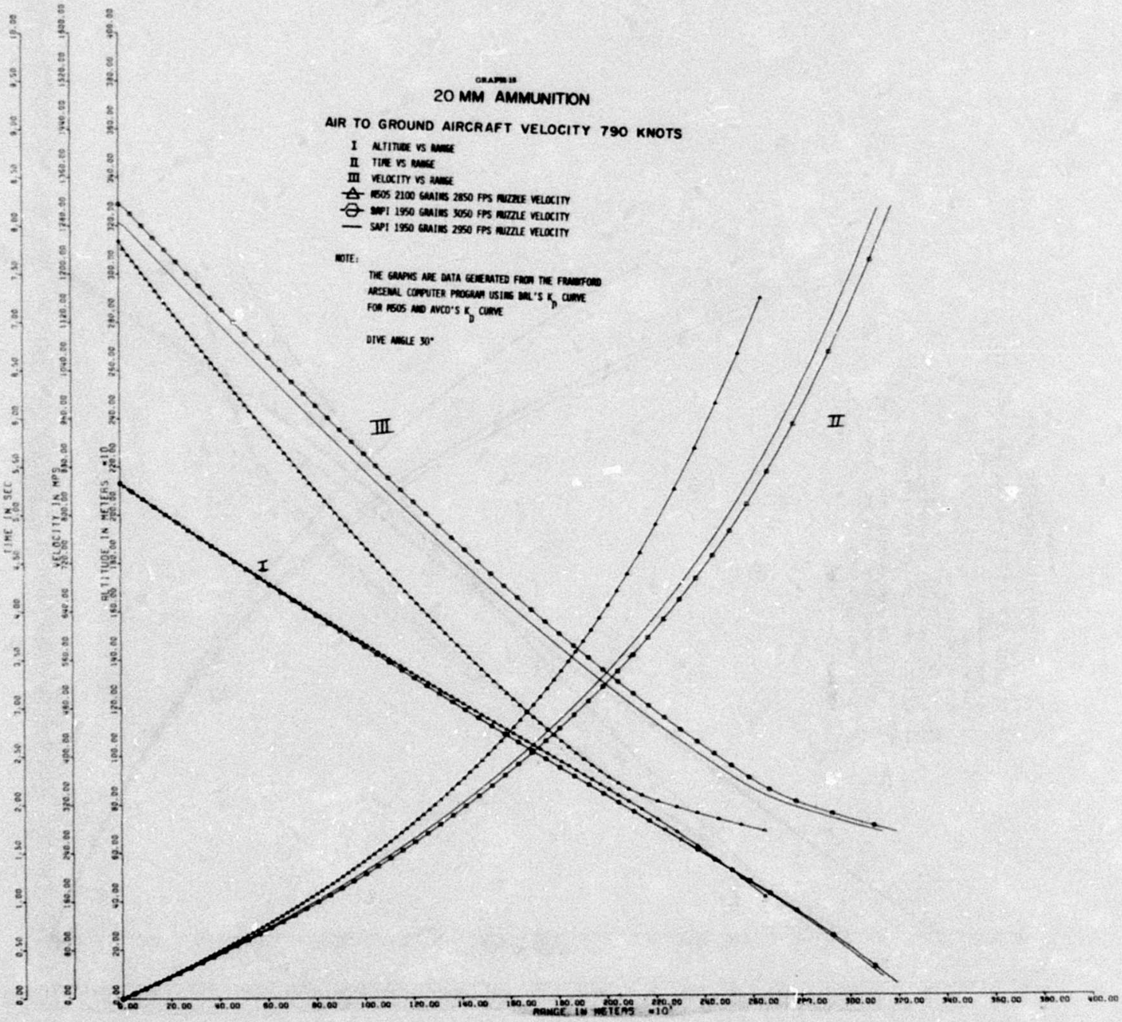

GRAPH 10
20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M505 1950 GRAINS 3050 FPS MUZZLE VELOCITY
SAPI 1950 GRAINS 3050 FPS MUZZLE VELOCITY
NOTE:
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL'S K_D CURVE FOR M505 AND AVCO's K_D CURVE
DIVE ANGLE 30°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS
III
II
I


GRAPH II
20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M505 2100 GRAINS 2850 FPS MUZZLE VELOCITY
SAPI 2100 GRAINS 2850 FPS MUZZLE VELOCITY
NOTE:
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL'S K_D CURVE FOR M505 AND AVCO'S K_D CURVE
DIVE ANGLE 30°
I
II
III
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS ×10¹
RANGE IN METERS ×10¹

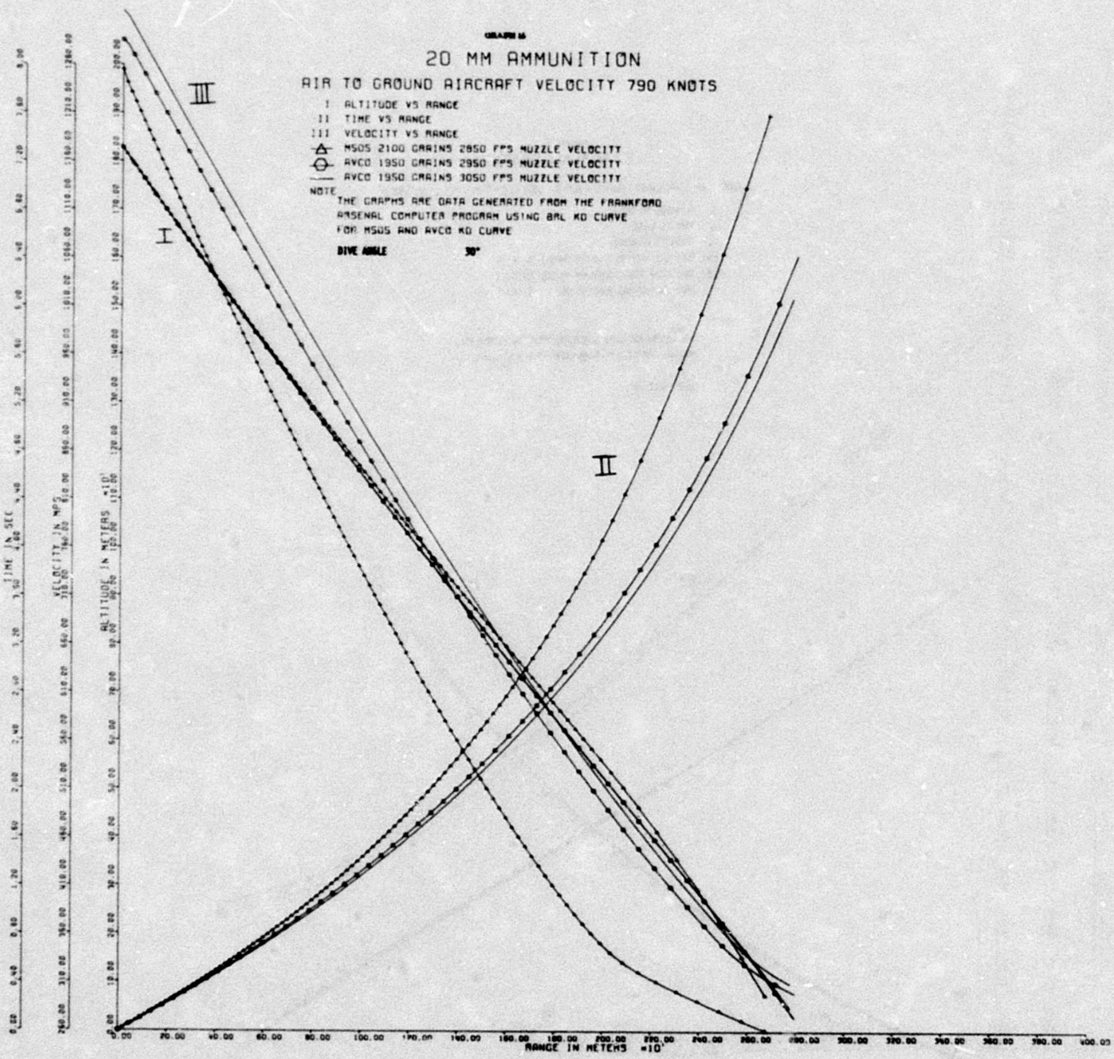

GRAPH 13
20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
AVCO 2100 GRAINS 2850 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2850 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M505 AND AVCO KD CURVE
DIVE ANGLE 30°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS ×10¹
RANGE IN METERS ×10¹
I
II
III

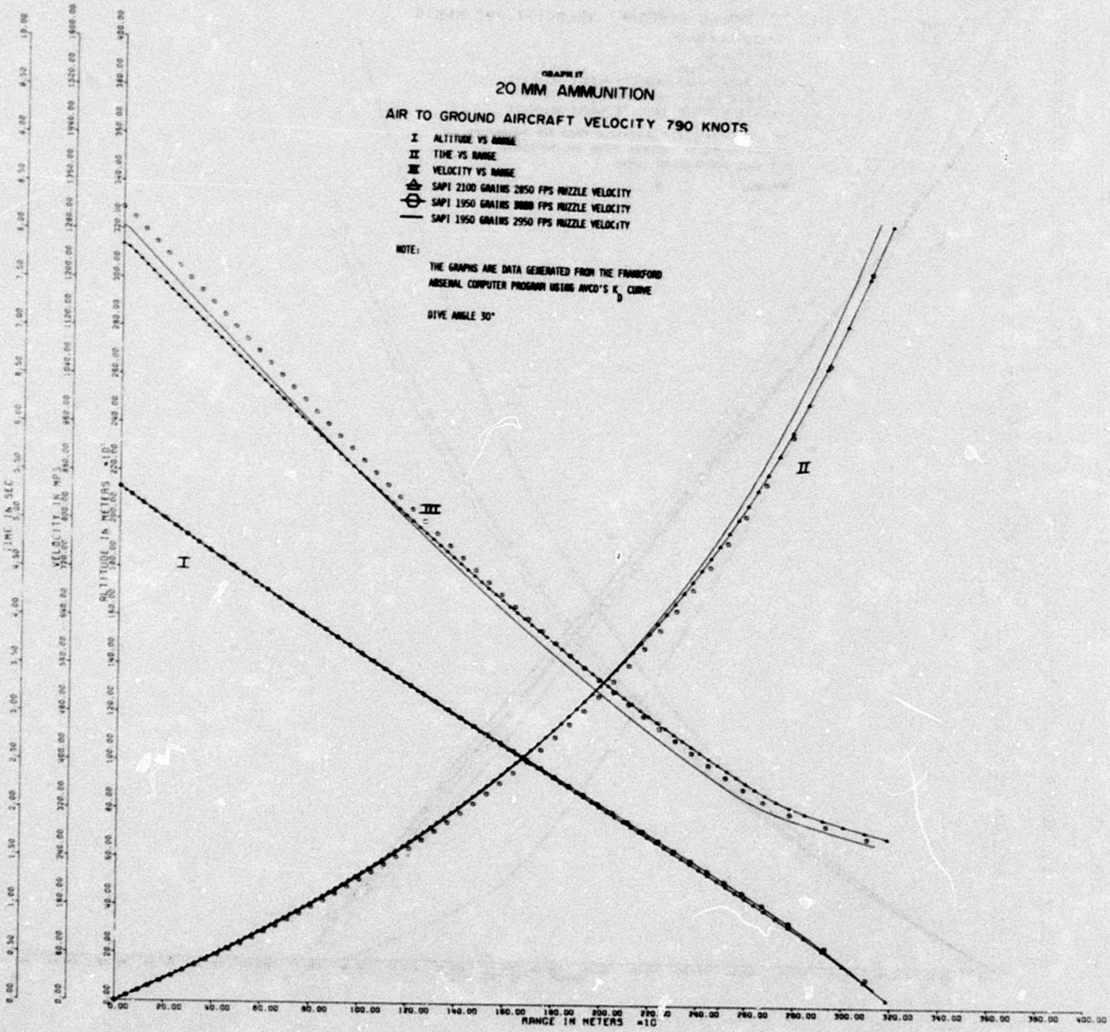

20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
SAPI 2100 GRAINS 2850.FPS MUZZLE VELOCITY
M505 1950 GRAINS 2950 FPS MUZZLE VELOCITY
M505 1950 GRAINS 3050 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M505 AND AVCO KD CURVE
DIVE ANGLE 30°
I
II
III
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS ×10
RANGE IN METERS ×10

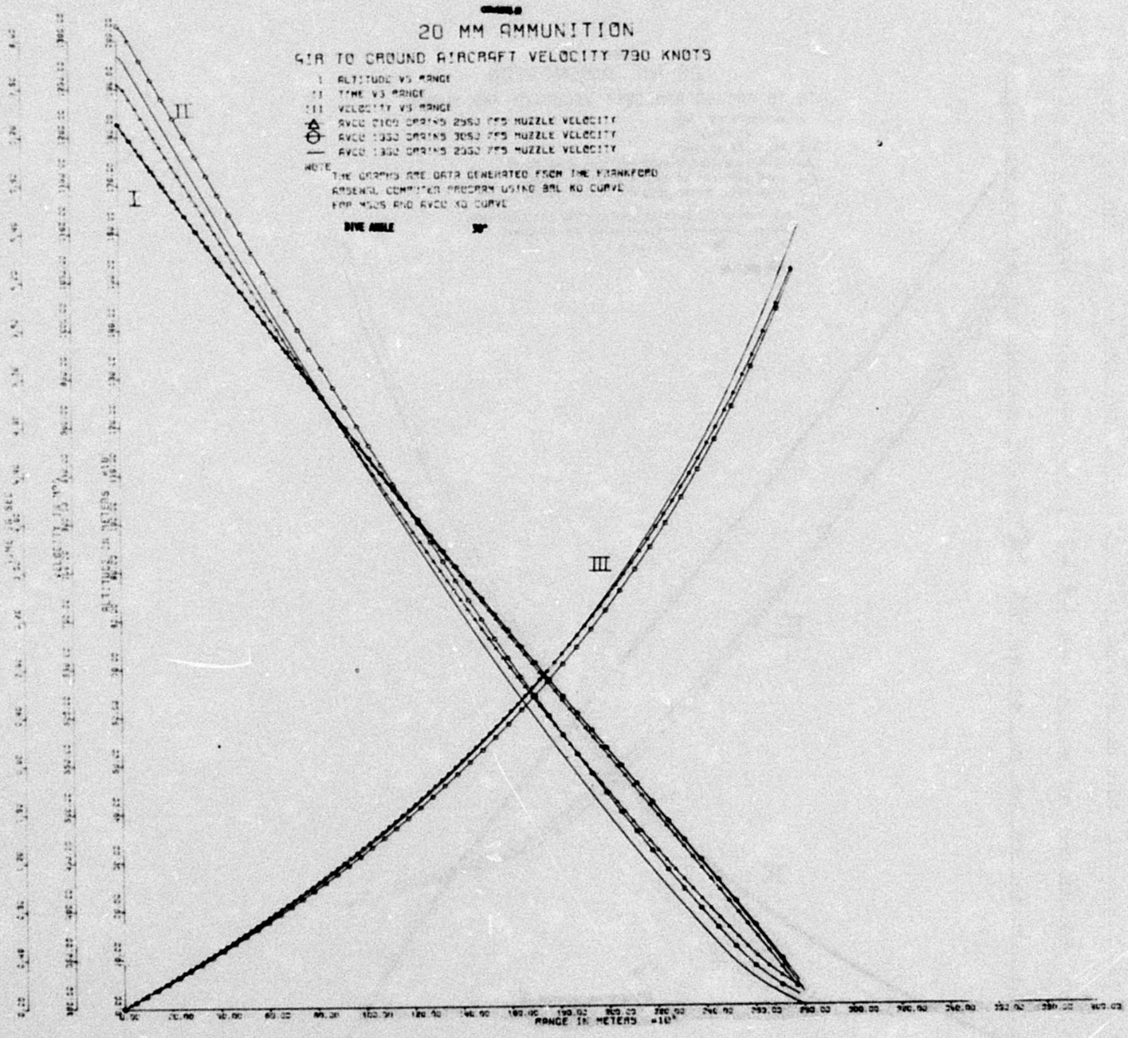

20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
AVCO 2100 GRAINS 2950 FPS MUZZLE VELOCITY
M505 1950 GRAINS 3050 FPS MUZZLE VELOCITY
M505 1950 GRAINS 2950 FPS MUZZLE VELOCITY
NOTE THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M505 AND AVCO KD CURVE.
I
II
III
ALTITUDE IN METERS
VELOCITY IN FPS
TIME IN SEC
RANGE IN METERS



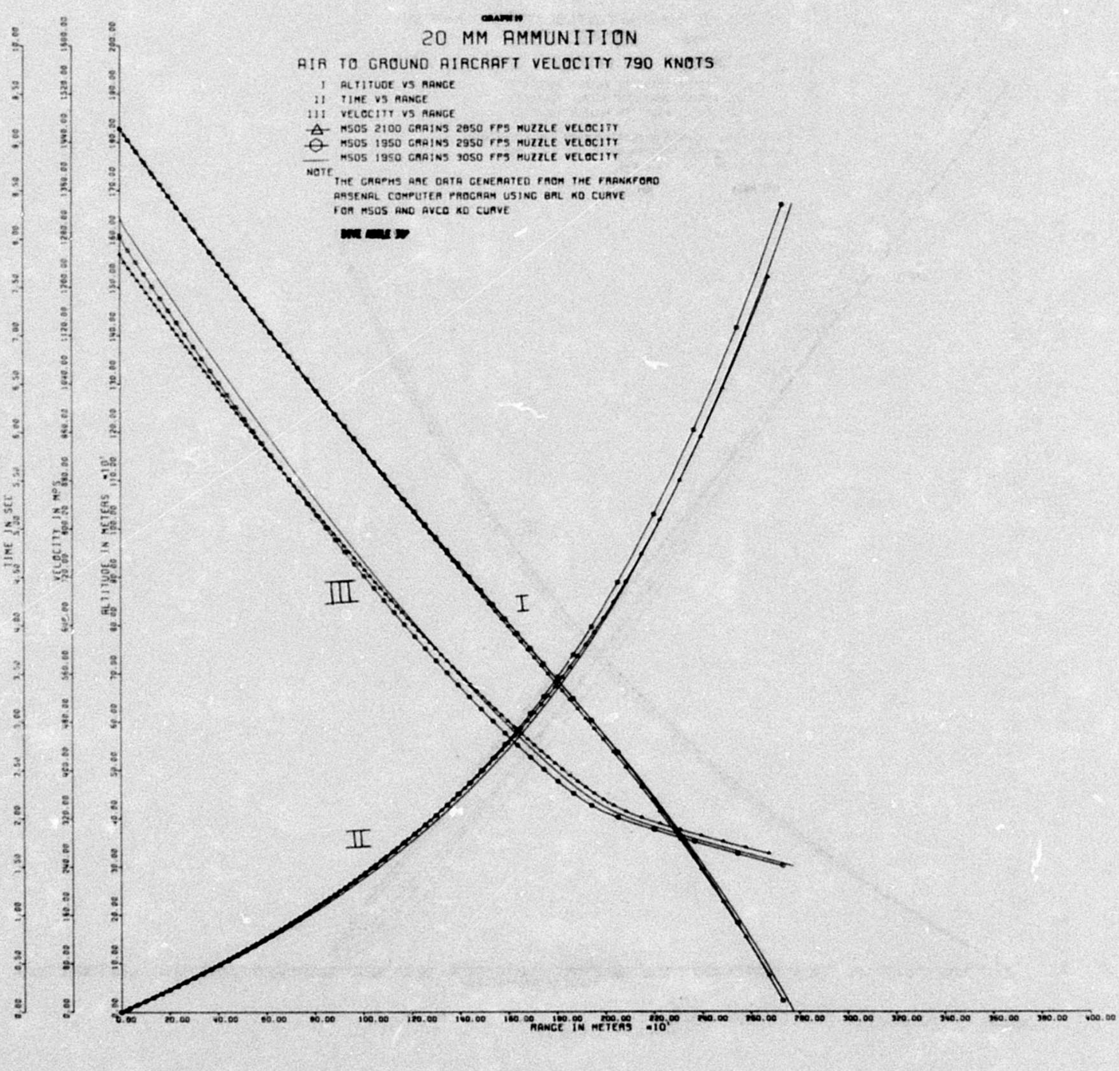
20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M505 2100 GRAINS 2850 FPS MUZZLE VELOCITY
SAPI 1950 GRAINS 3050 FPS MUZZLE VELOCITY
SAPI 1950 GRAINS 2950 FPS MUZZLE VELOCITY
NOTE:
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL'S K CURVE FOR M505 AND AVCO'S K CURVE
DIVE ANGLE 30°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS ×10
RANGE IN METERS ×10
III
II
I

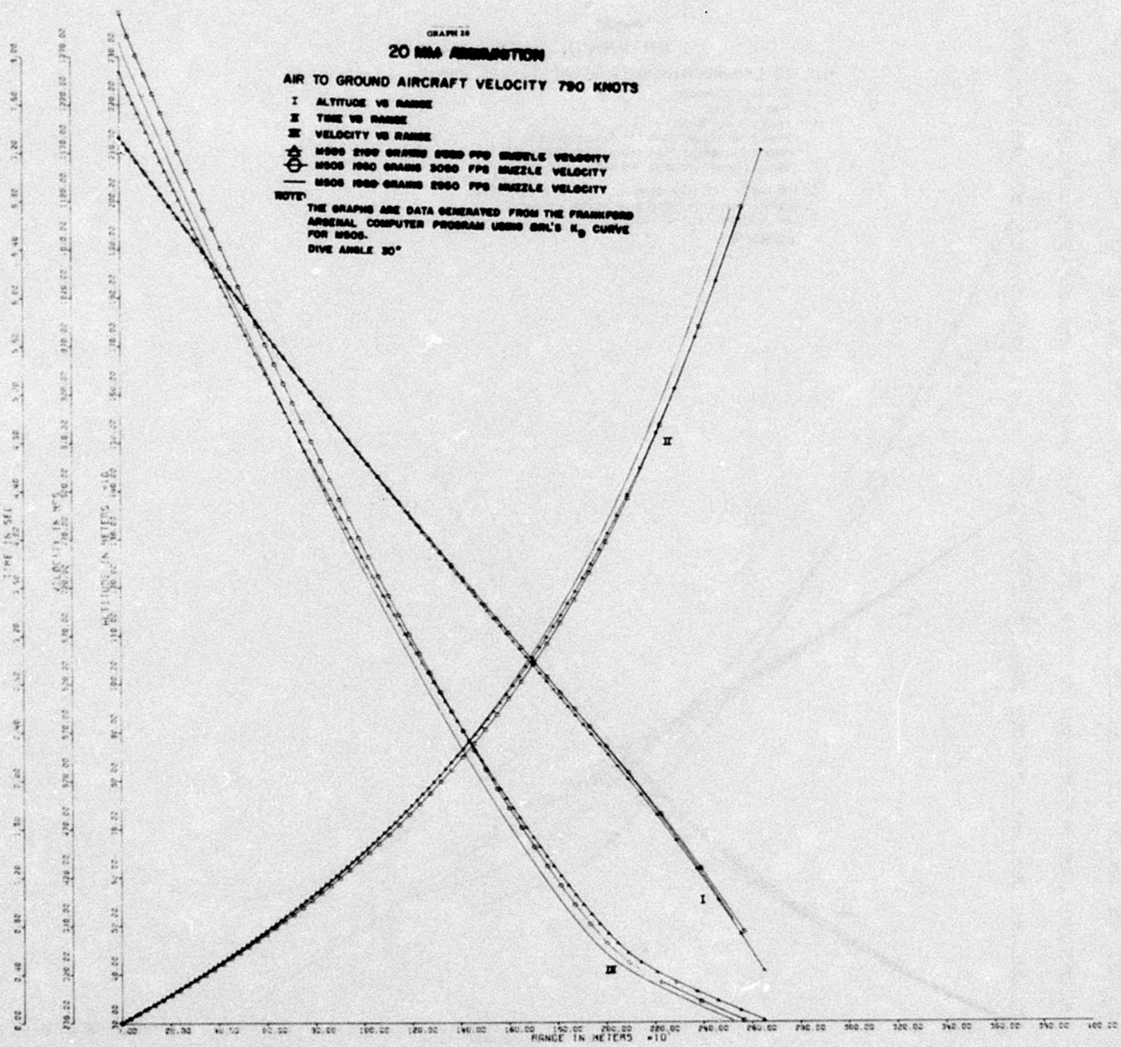

20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
MSOS 2100 GRAINS 2850 FPS MUZZLE VELOCITY
AVCO 1950 GRAINS 2950 FPS MUZZLE VELOCITY
AVCO 1950 GRAINS 3050 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR MSOS AND AVCO KD CURVE
DIVE ANGLE 30°
III
I
II
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS

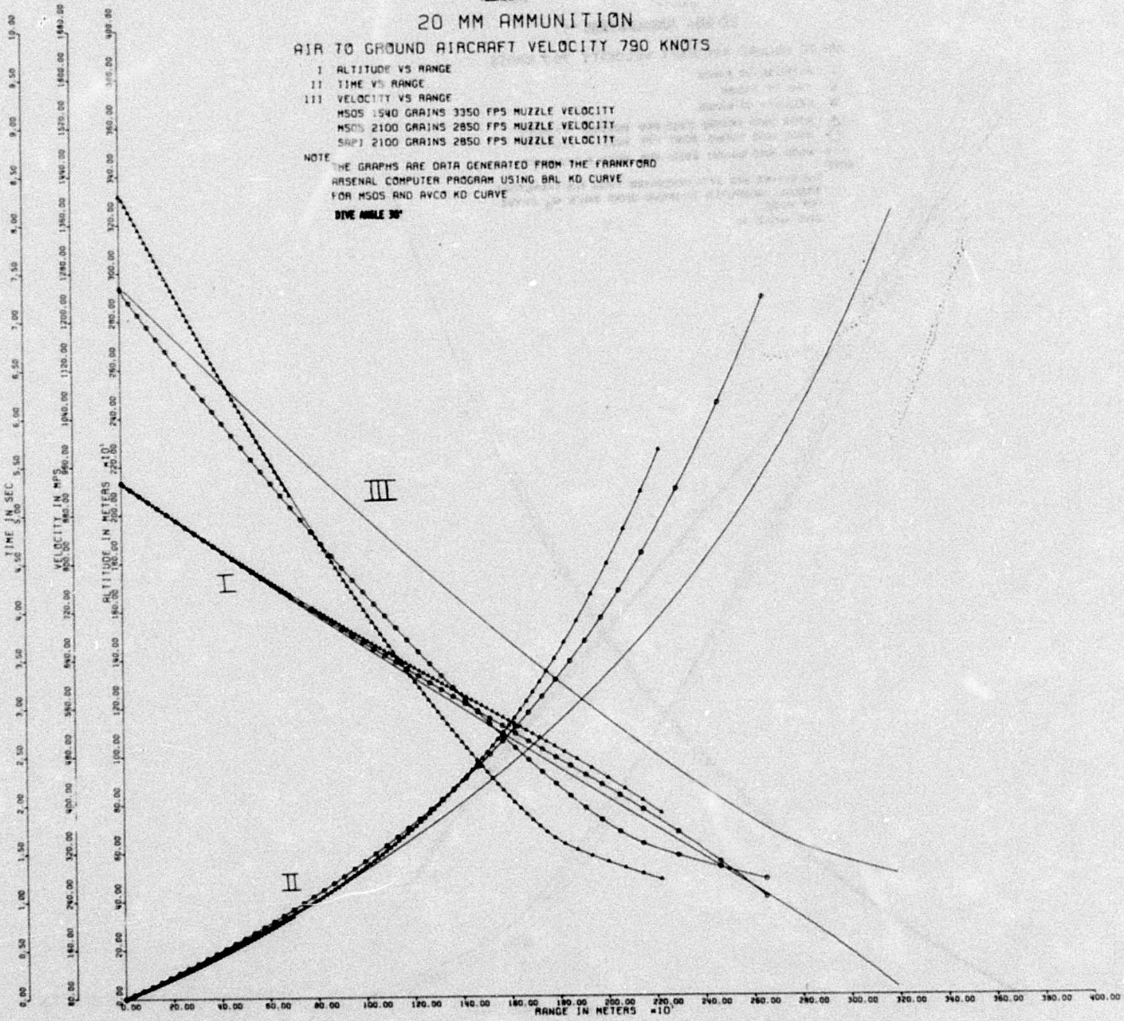

20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
SAPI 2100 GRAINS 2850 FPS MUZZLE VELOCITY
SAPI 1950 GRAINS FPS MUZZLE VELOCITY
SAPI 1950 GRAINS 2950 FPS MUZZLE VELOCITY
NOTE:
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING AVCO'S K_D CURVE
DIVE ANGLE 30°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS *10
RANGE IN METERS *10
I
II
III



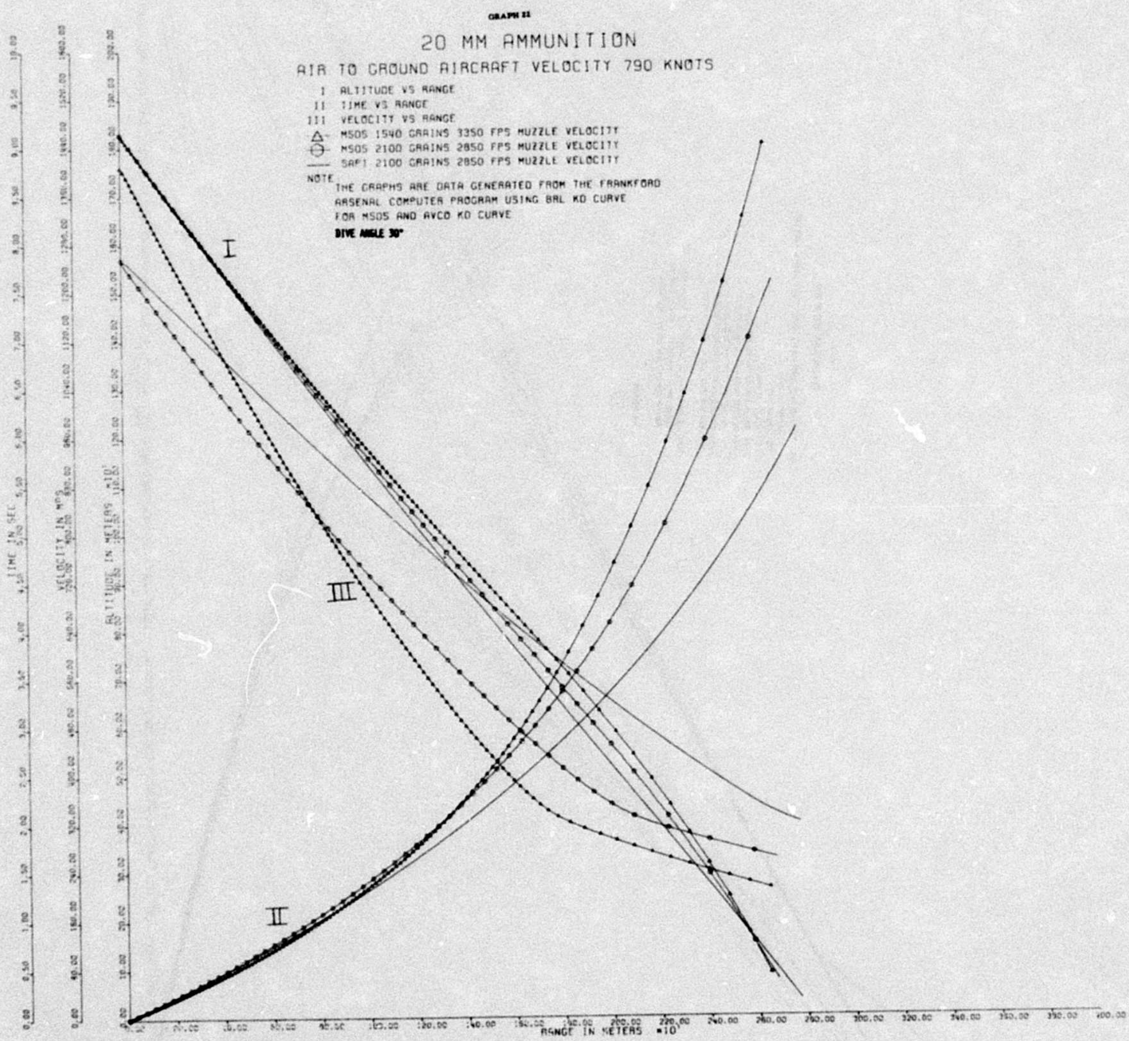
[redacted]
20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
AVCO 2100 GRAINS 2550 FPS MUZZLE VELOCITY
AVCO 1950 GRAINS 3050 FPS MUZZLE VELOCITY
AVCO 1950 GRAINS 2050 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M525 AND AVCO KD CURVE
DIVE ANGLE 30°
I
II
III
RANGE IN METERS

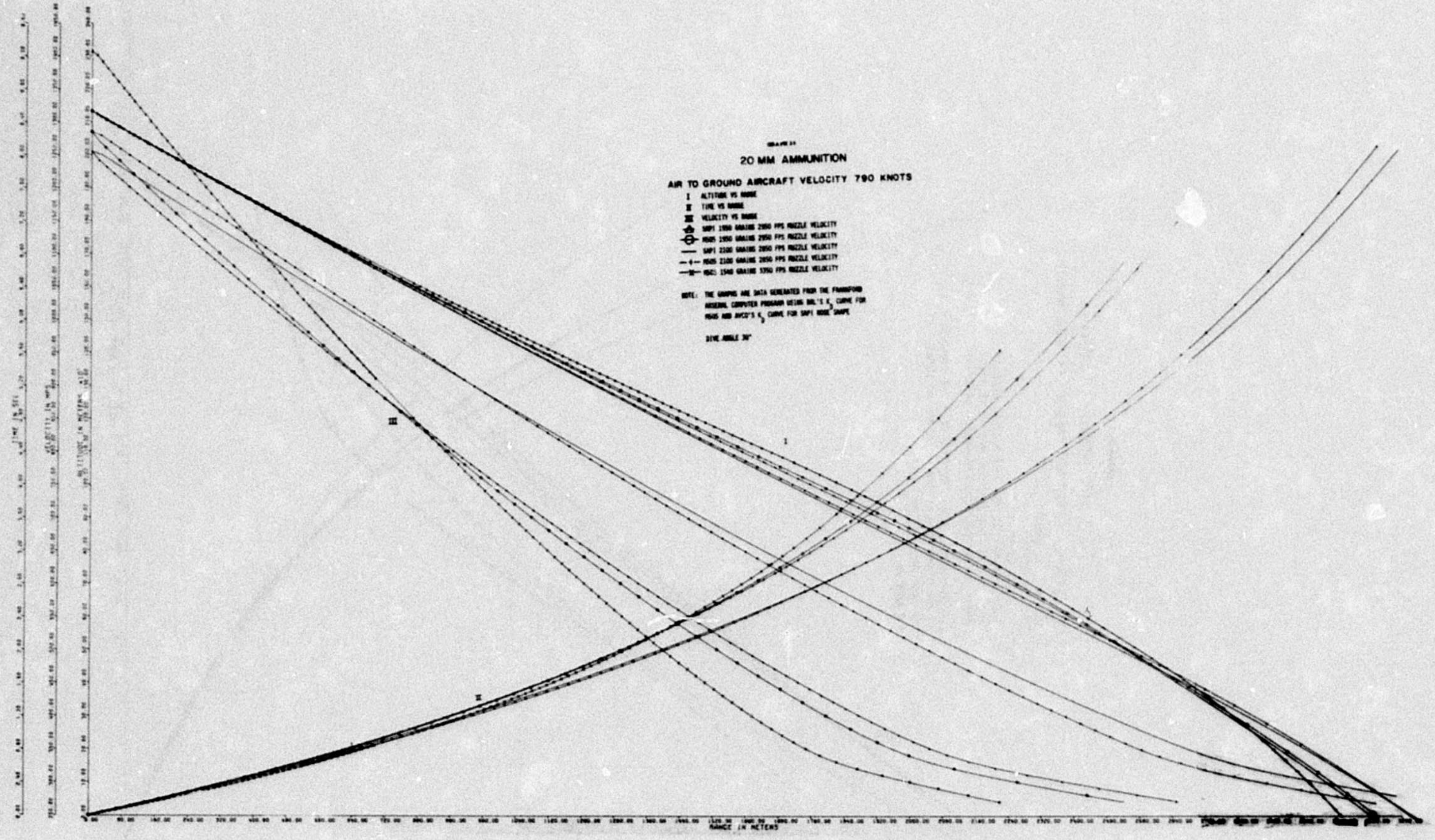

20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M505 2100 GRAINS 2850 FPS MUZZLE VELOCITY
M505 1950 GRAINS 2950 FPS MUZZLE VELOCITY
M505 1950 GRAINS 3050 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M505 AND AVCO KD CURVE
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS *10¹
RANGE IN METERS *10¹
I
II
III


AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
DIVE ANGLE 30°
RANGE IN METERS *10

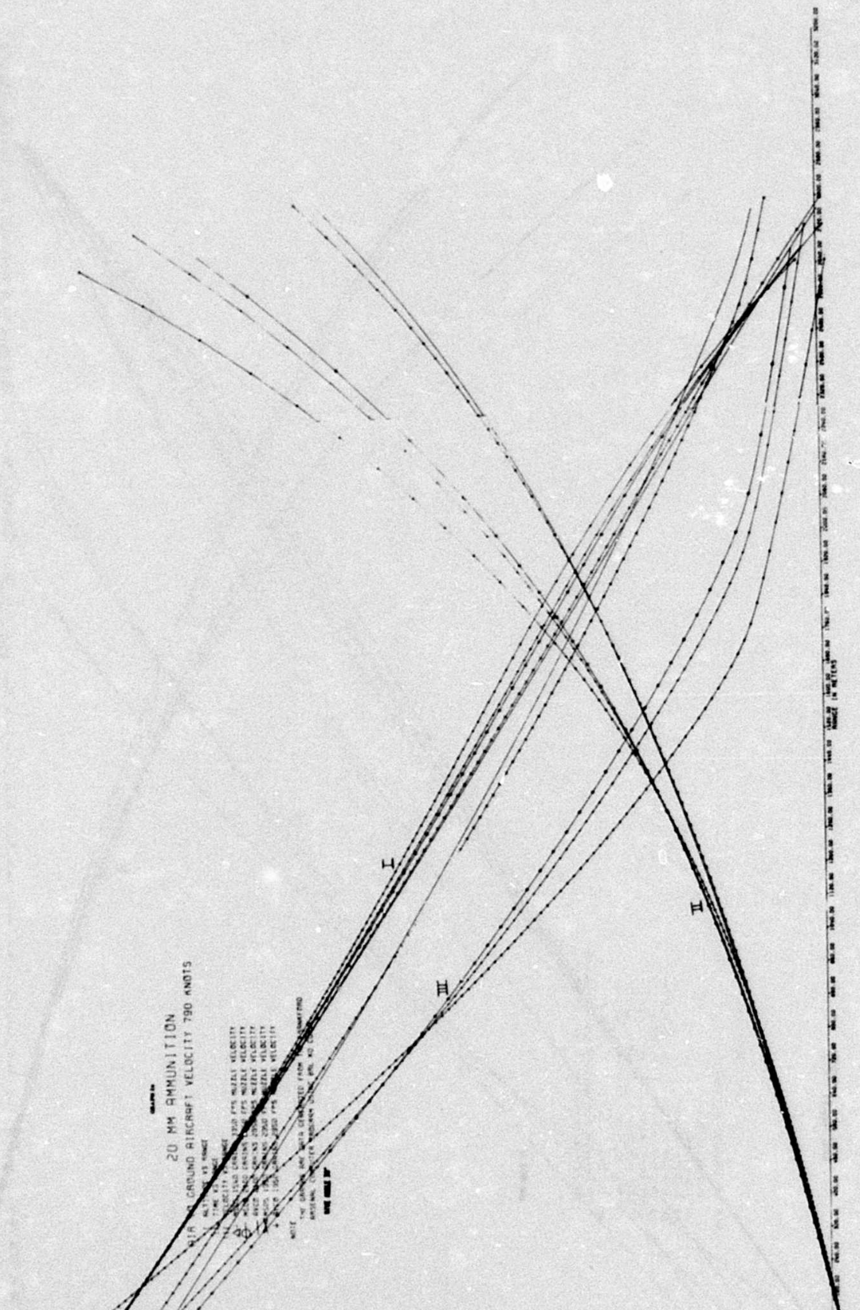


20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M505 1540 GRAINS 3350 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2850 FPS MUZZLE VELOCITY
SAPI 2100 GRAINS 2850 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BAL KD CURVE FOR M505 AND AVCO KD CURVE
DIVE ANGLE 30°
I
II
III
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS ×10¹
RANGE IN METERS ×10¹

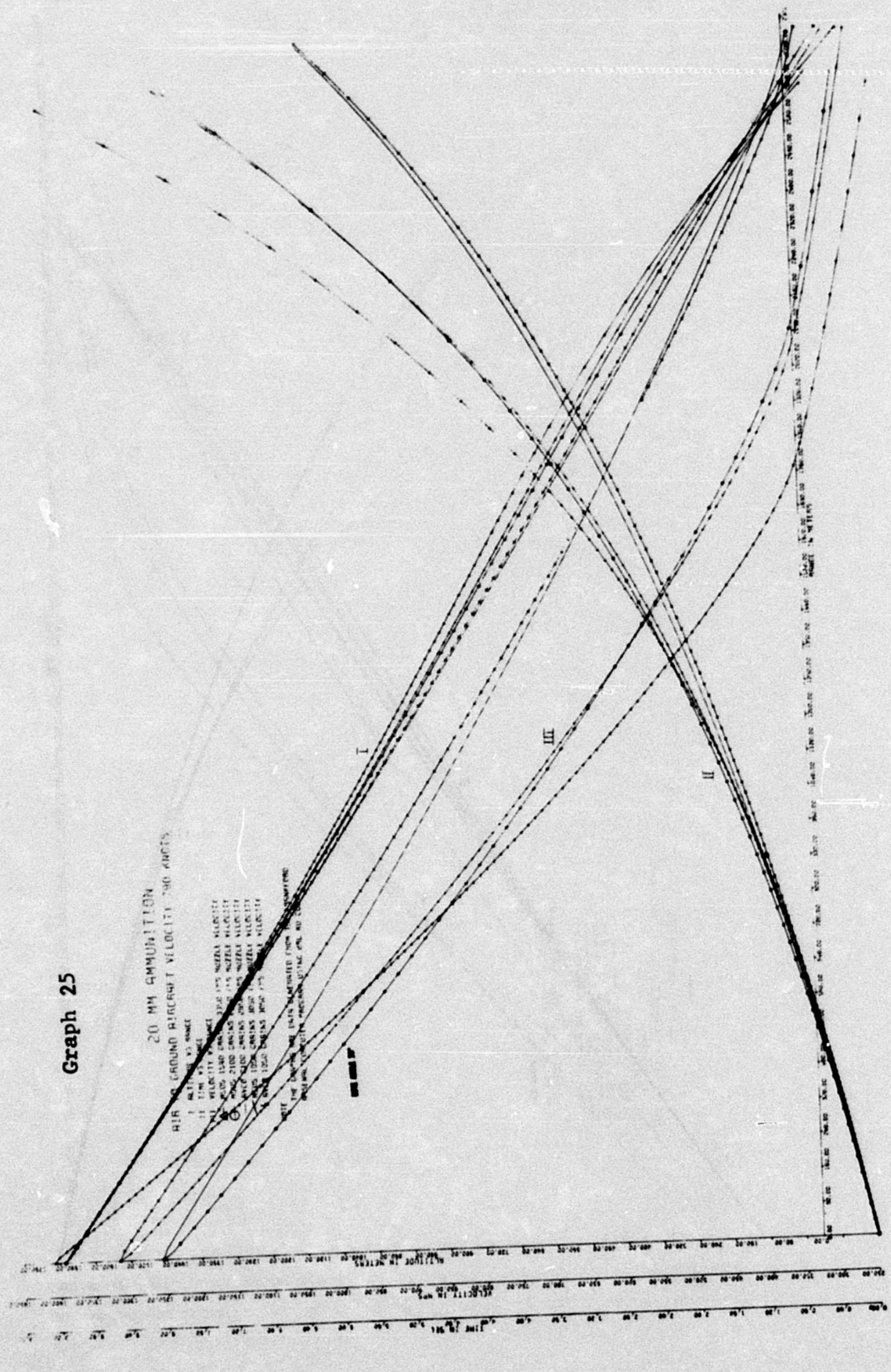

GRAPH II
20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
MSOS 1540 GRAINS 3350 FPS MUZZLE VELOCITY
MSOS 2100 GRAINS 2850 FPS MUZZLE VELOCITY
SAFI 2100 GRAINS 2850 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR MSOS AND AVCO KD CURVE
DIVE ANGLE 30°
I
II
III
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS

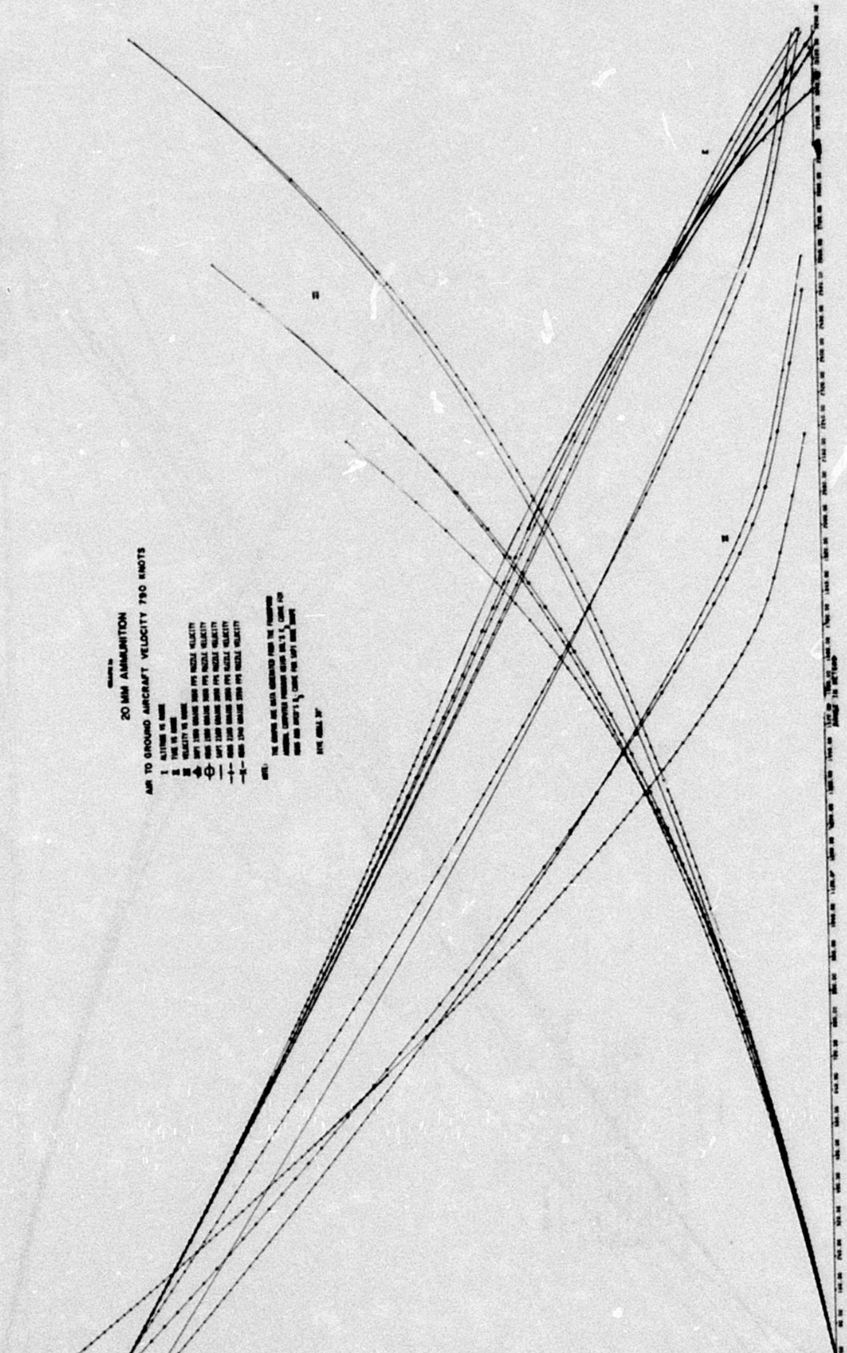


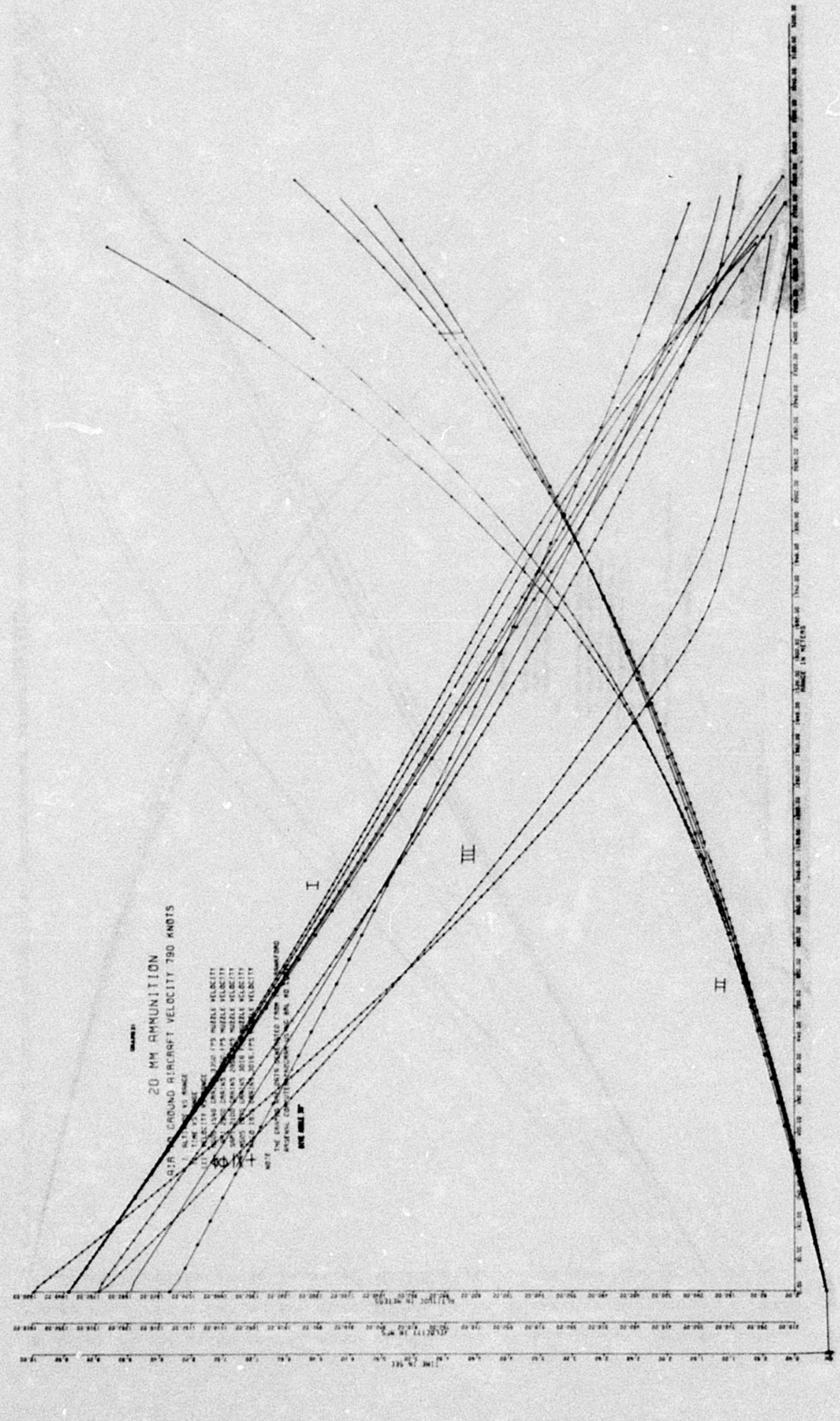
20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
DIVE ANGLE 30°
RANGE IN METERS

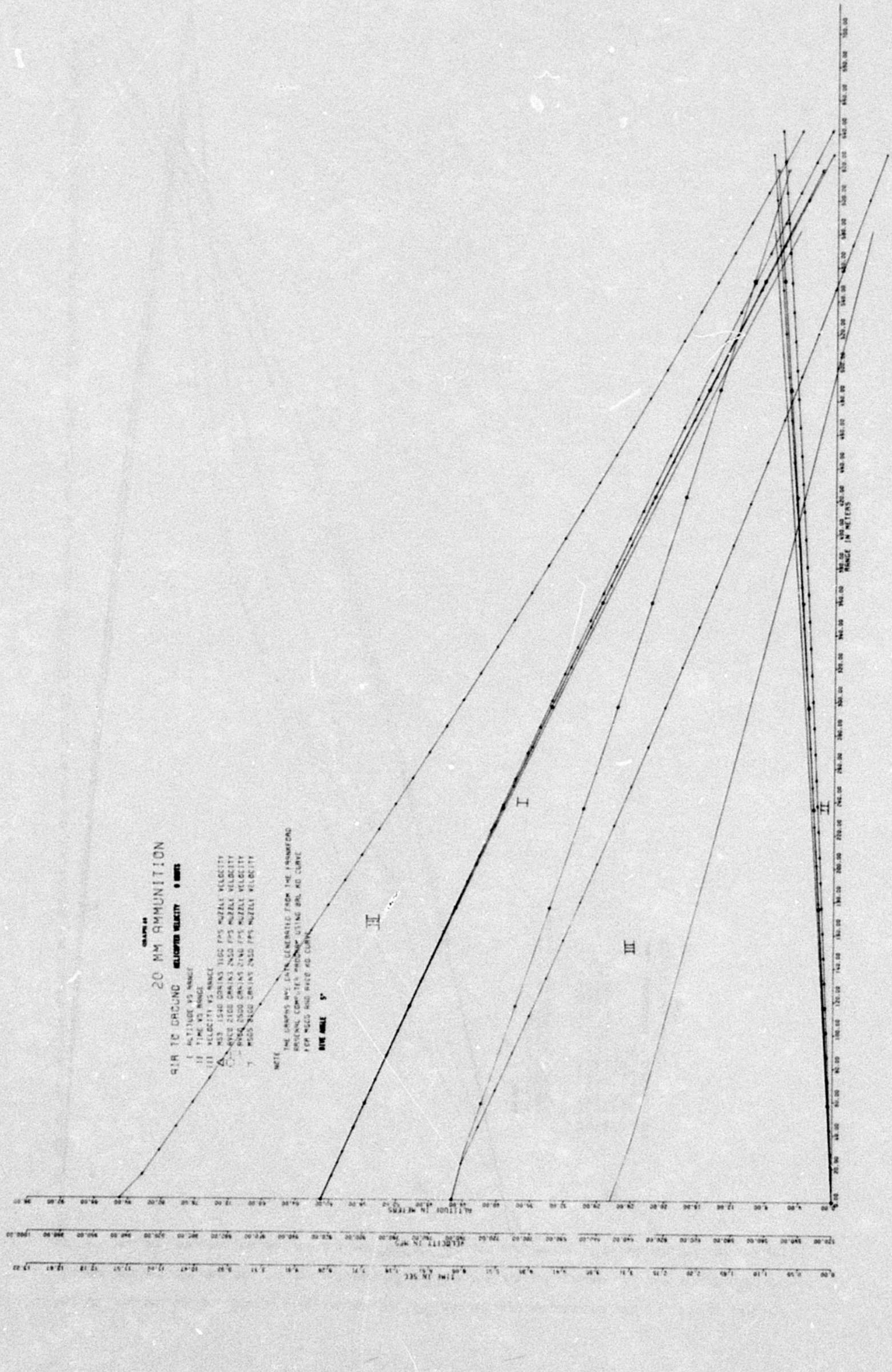

20 MM AMMUNITION
GROUND AIRCRAFT VELOCITY 790 KNOTS
MUZZLE VELOCITY
MUZZLE VELOCITY
VELOCITY
VELOCITY
VELOCITY
NOTE
RANGE IN METERS
I
II
III

Graph 25

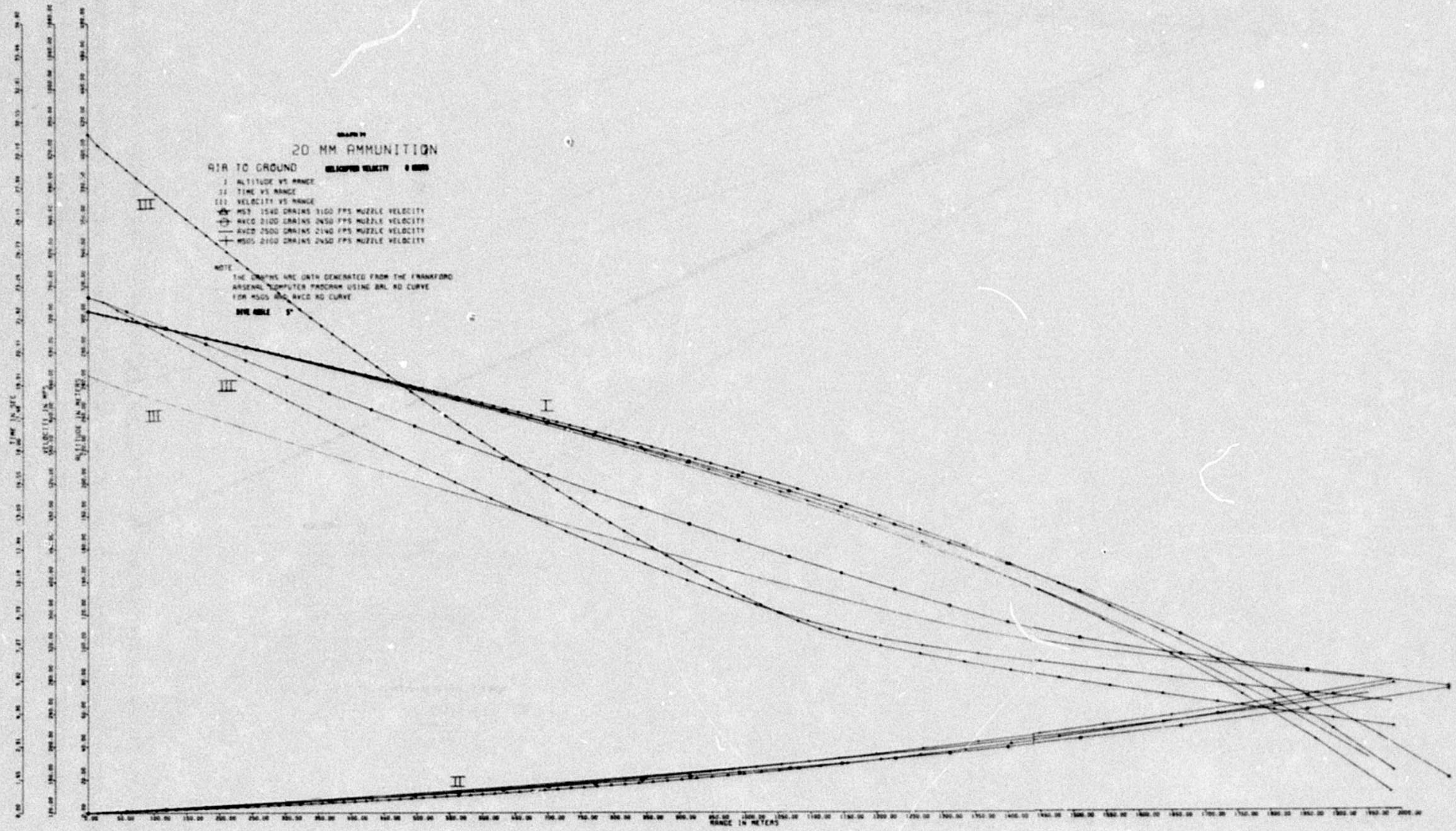


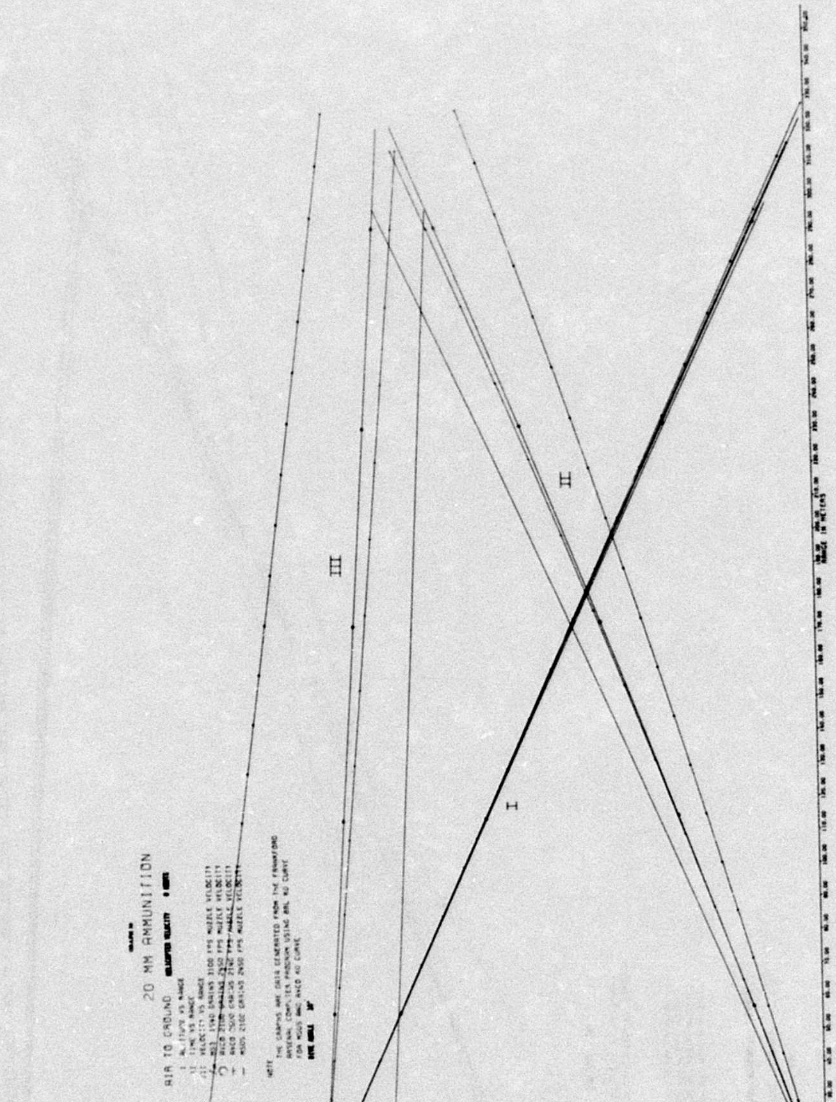

20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
ALTITUDE VS RANGE
TIME VS RANGE
VELOCITY VS RANGE

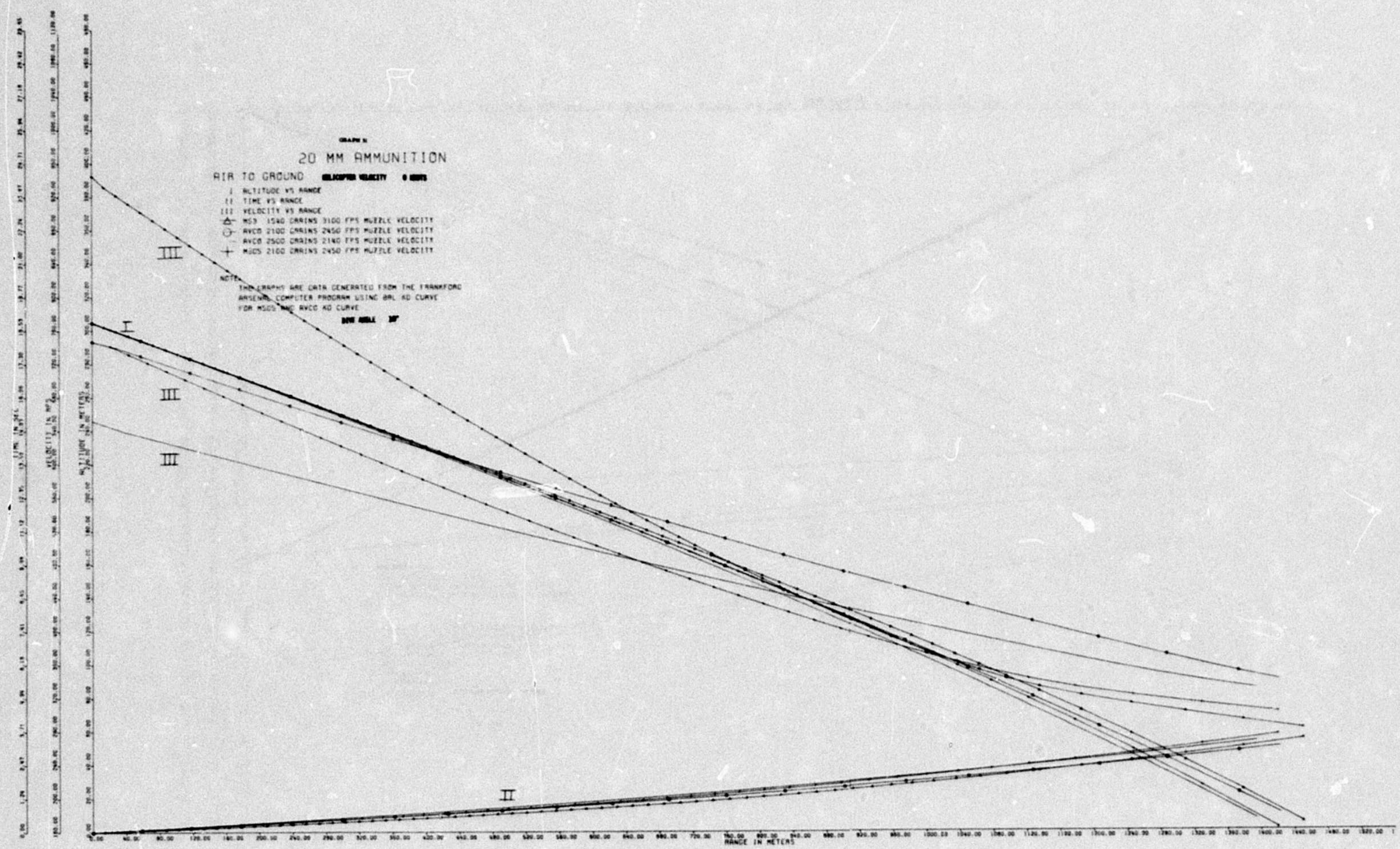

20 MM AMMUNITION
AIR TO GROUND AIRCRAFT VELOCITY 790 KNOTS
I
II
III

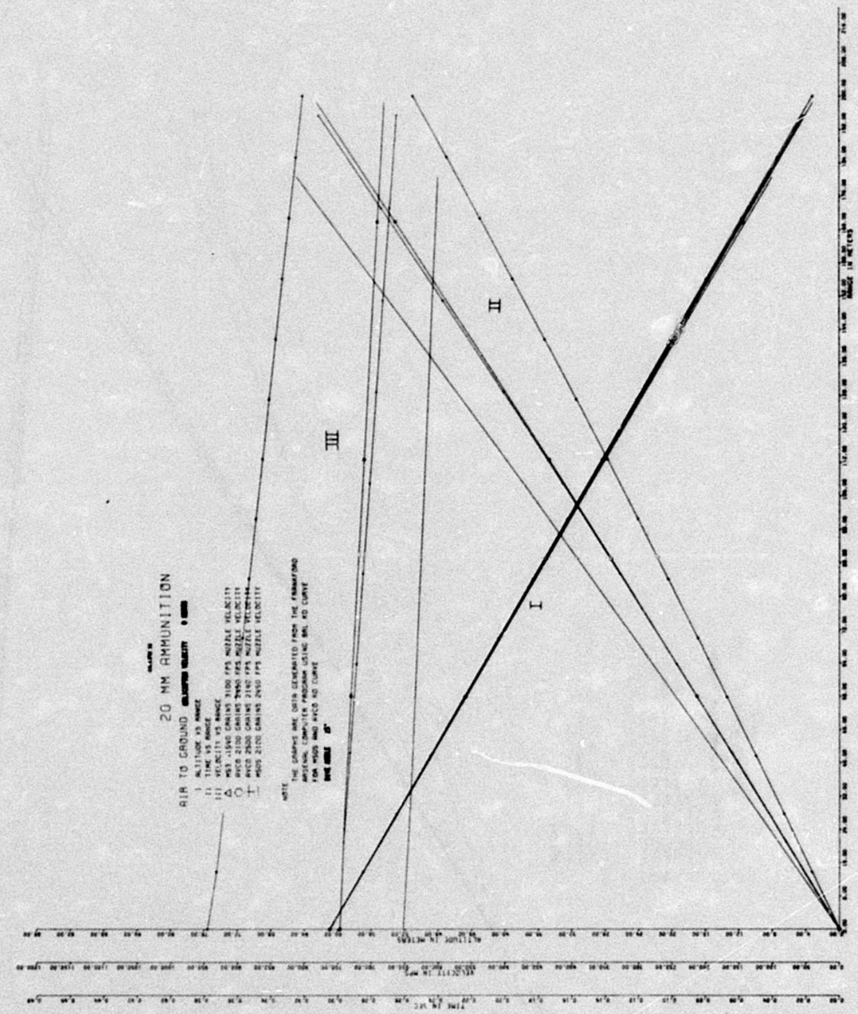


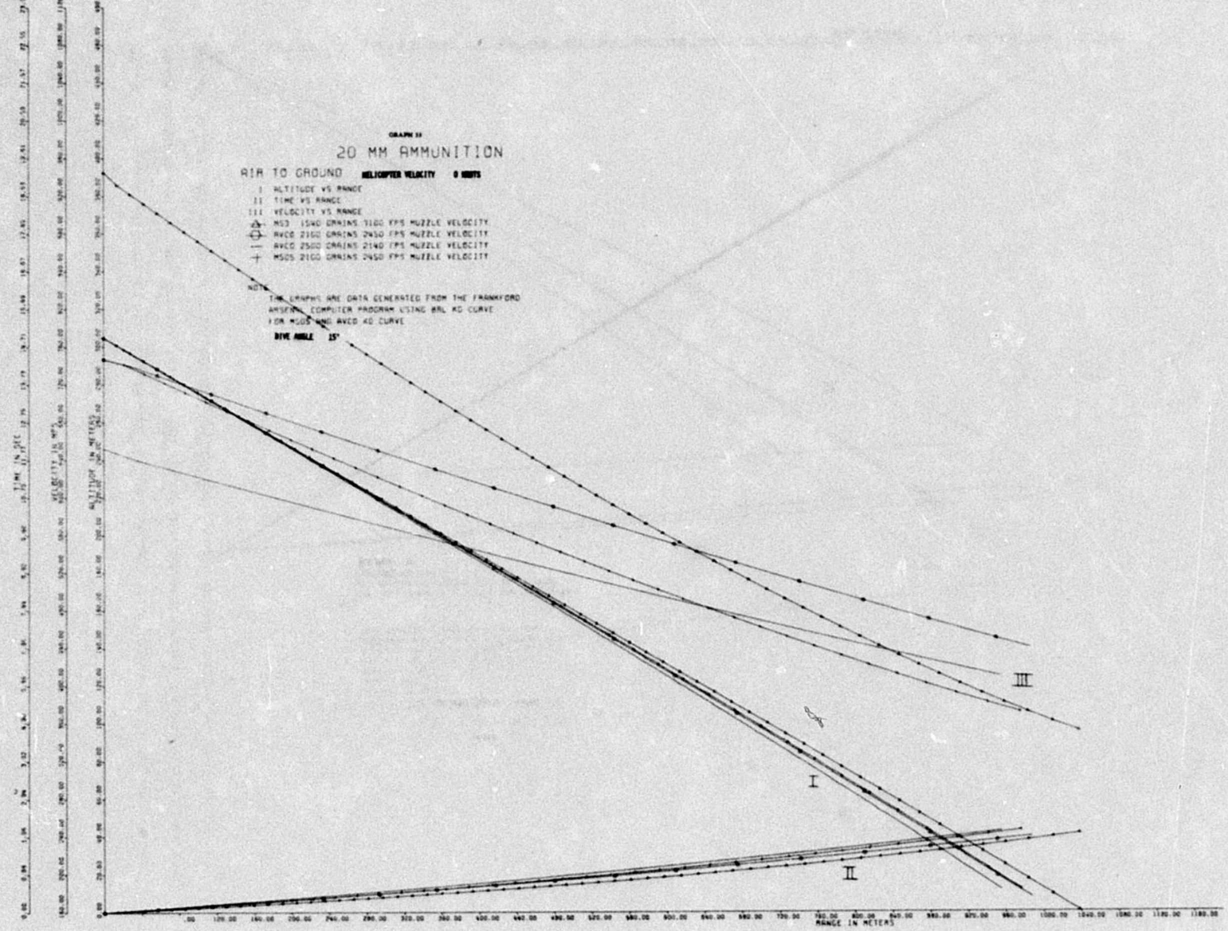
AIR TO GROUND
20 MM AMMUNITION
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
NOTE
DIVE ANGLE 5°
RANGE IN METERS
I
II
III

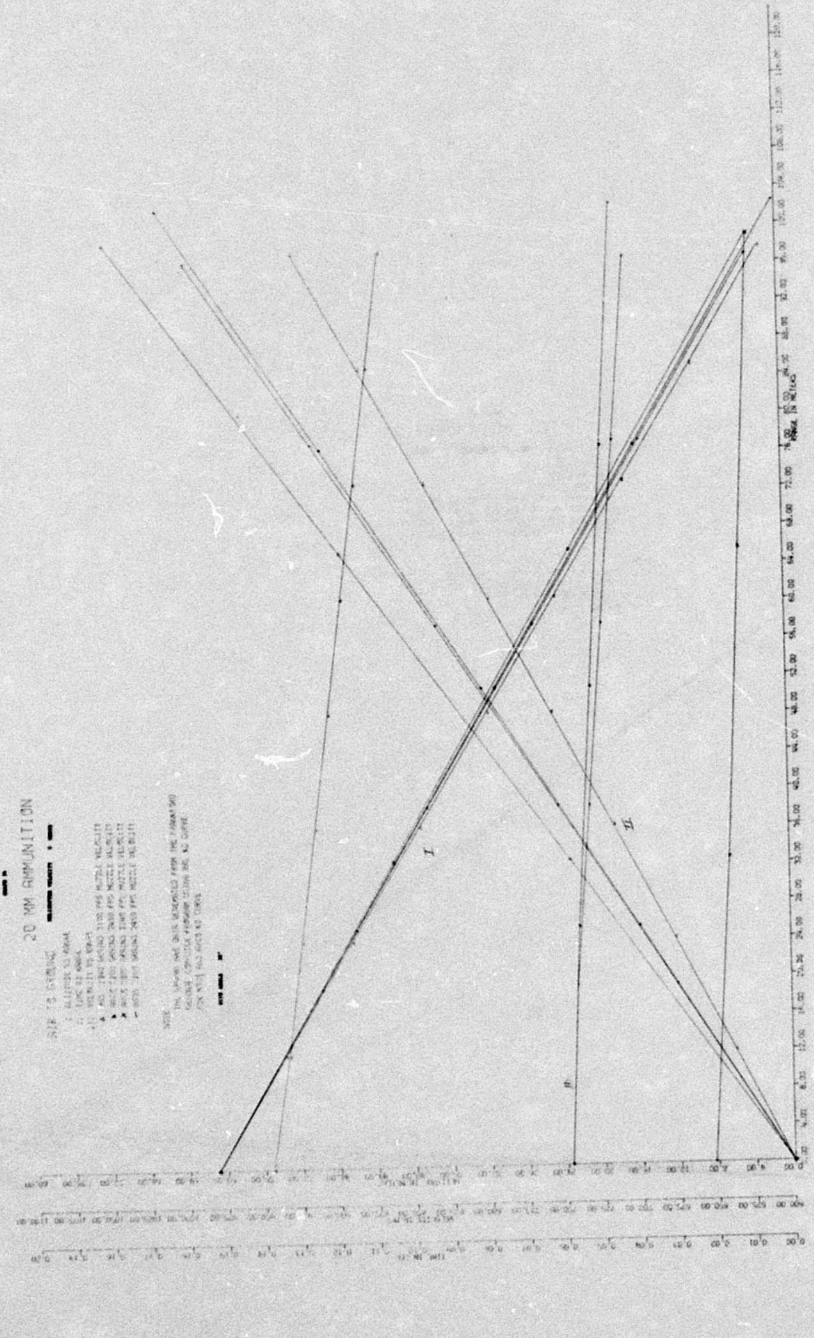

20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M505 AND AVCO KD CURVE
5°
RANGE IN METERS
I
II
III
III
III

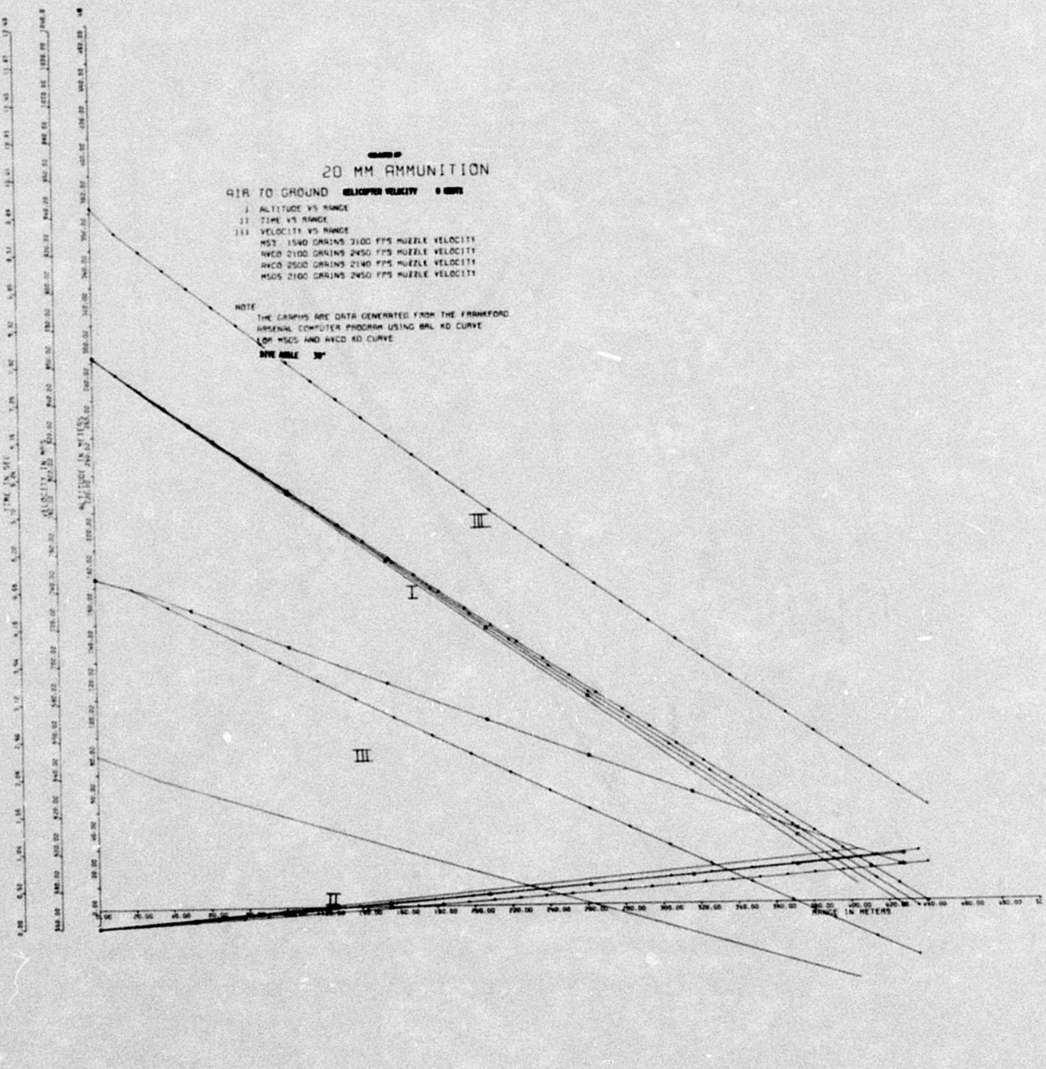

20 MM AMMUNITION
AIR TO GROUND
TIME VS RANGE
VELOCITY VS RANGE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR MSDS AND AVCO KD CURVE
RANGE IN METERS
I
II
III

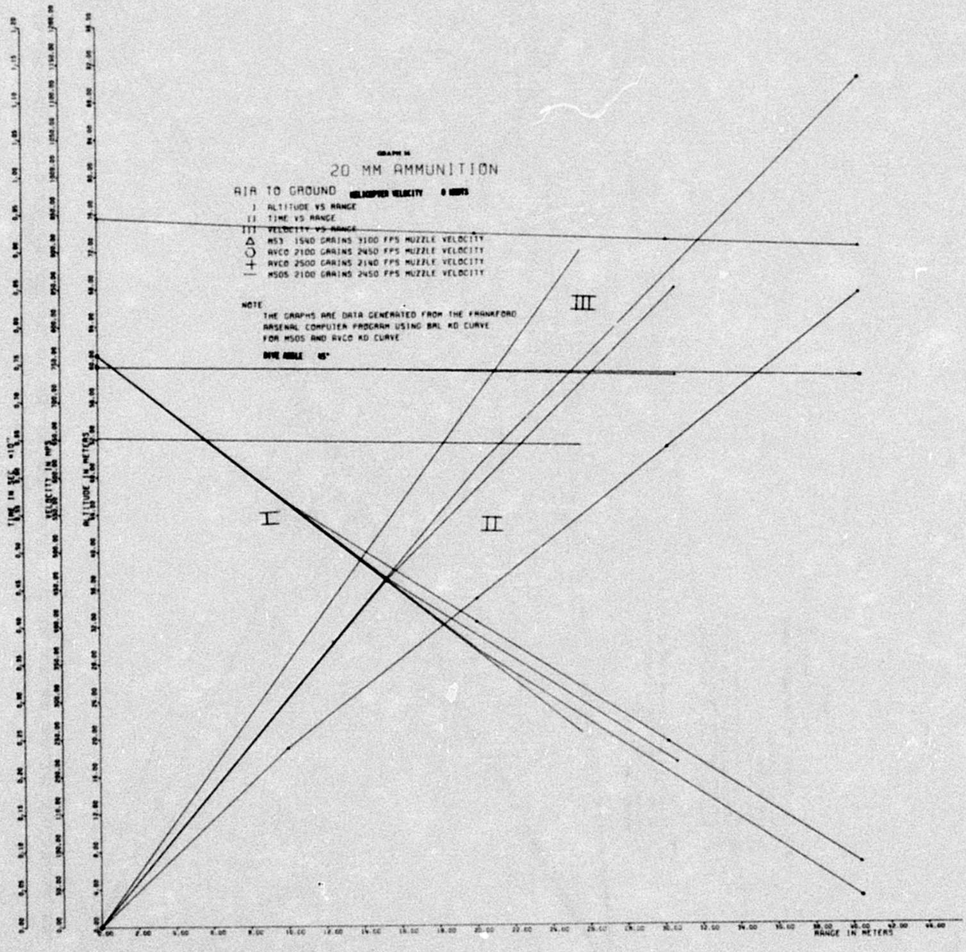

20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE:
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M505 AND AVCO KD CURVE
RANGE IN METERS
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC

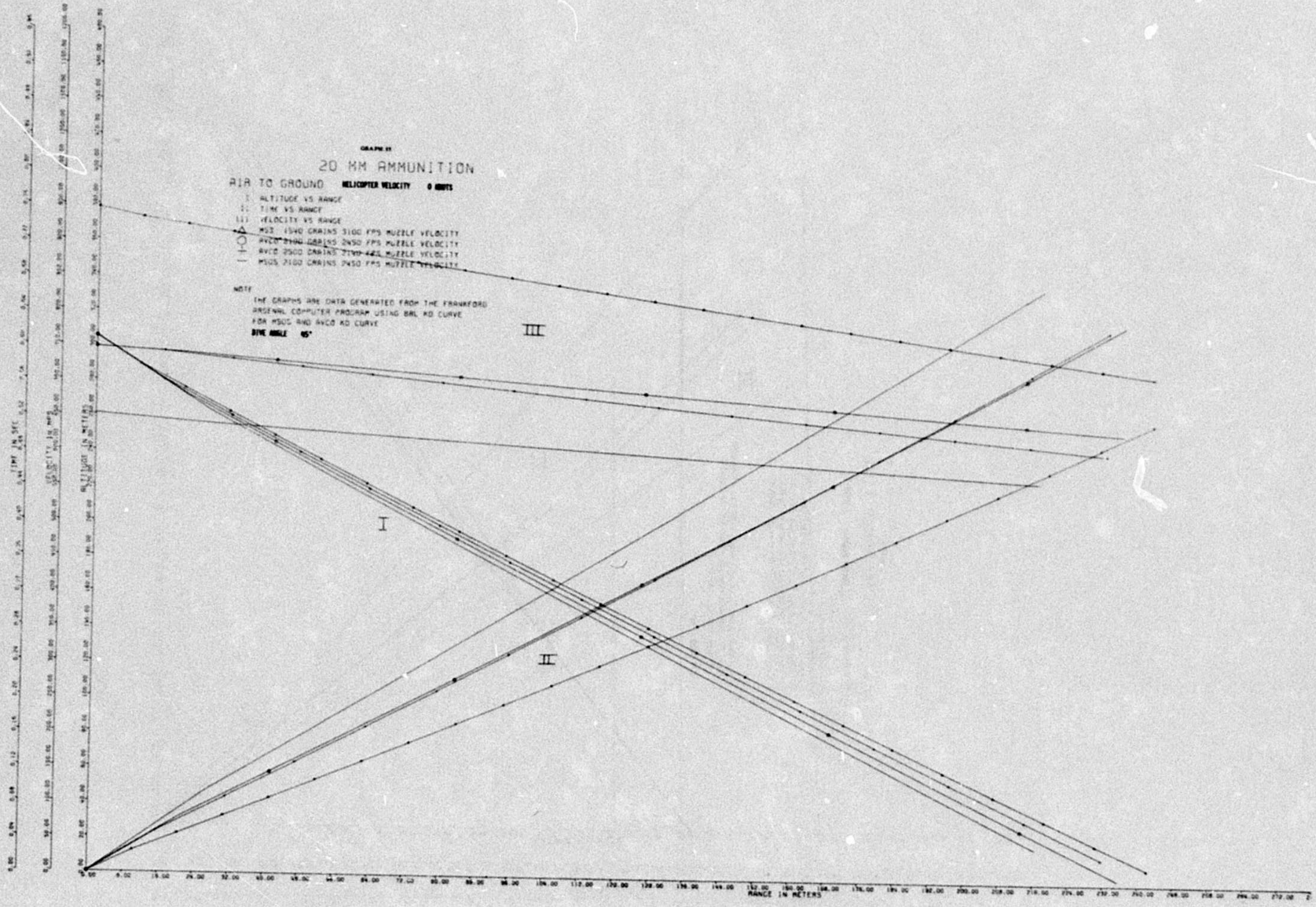

20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 .1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
MSDS 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR MSDS AND AVCO KD CURVE
I
II
III
RANGE IN METERS
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC

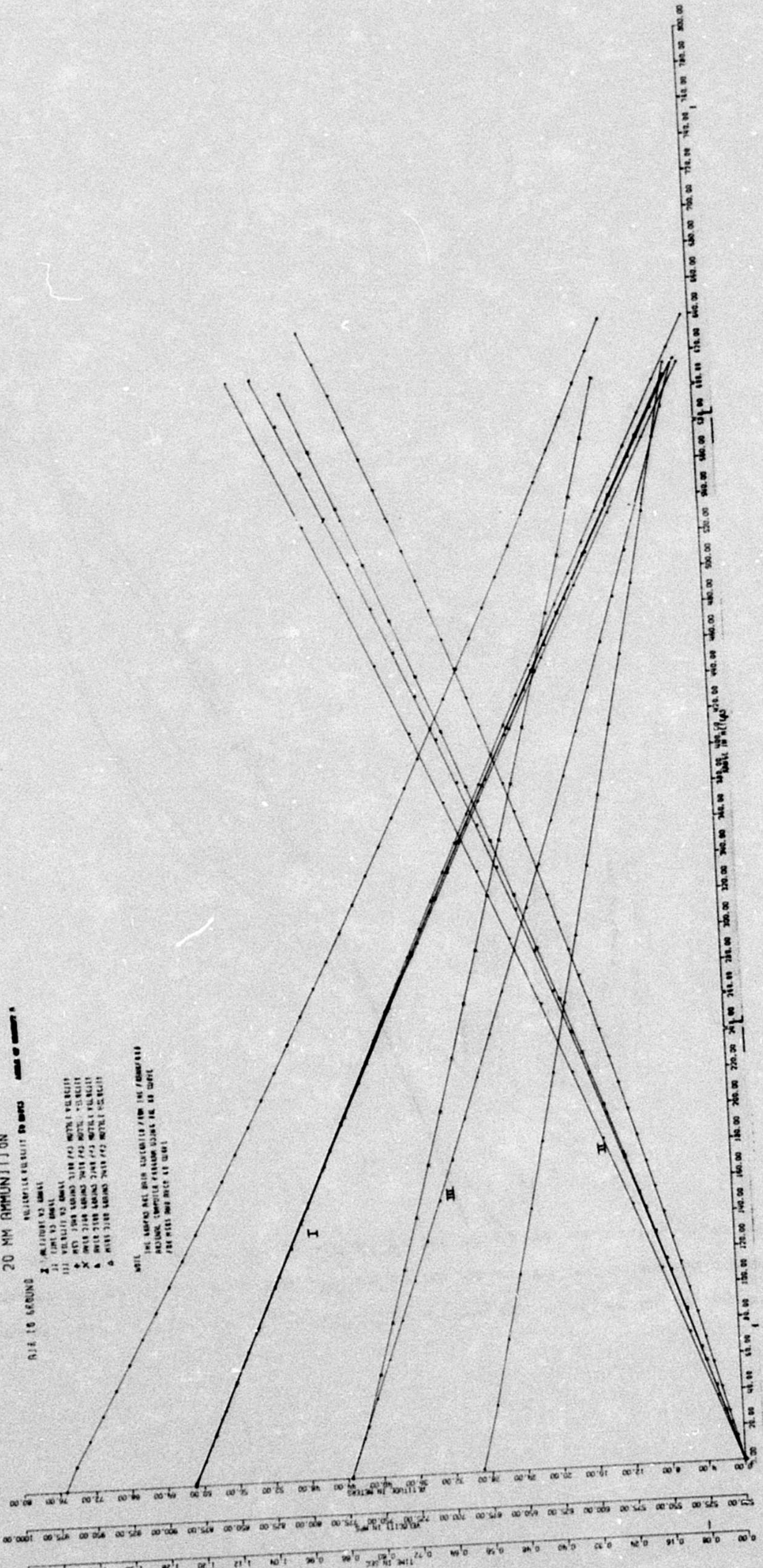

GRAPH
20 MM AMMUNITION
AIR TO GROUND HELICOPTER VELOCITY 0 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
MSOS 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR MSOS AND AVCO KD CURVE
DIVE ANGLE 15°
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC
RANGE IN METERS
I
II
III

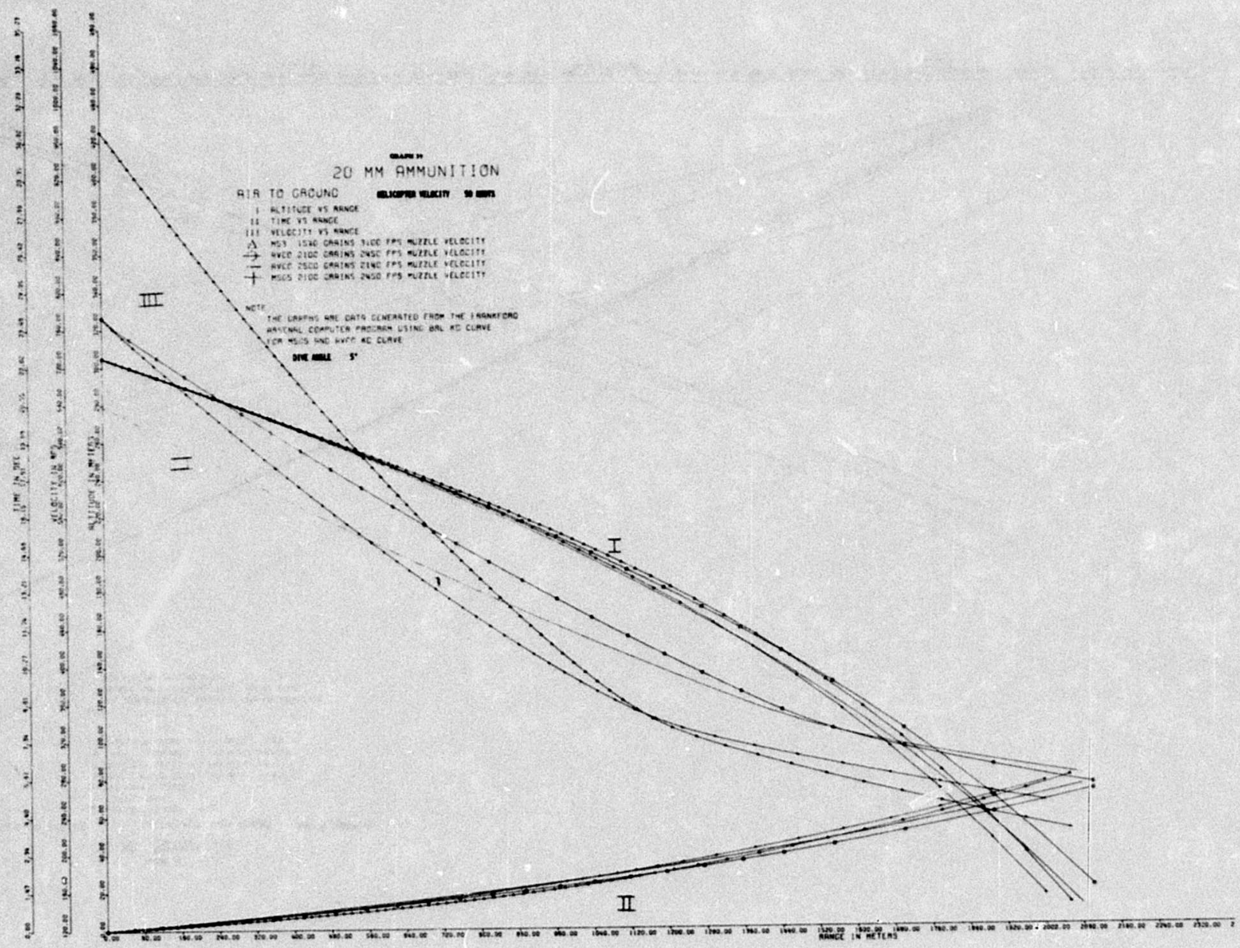

20 MM AMMUNITION

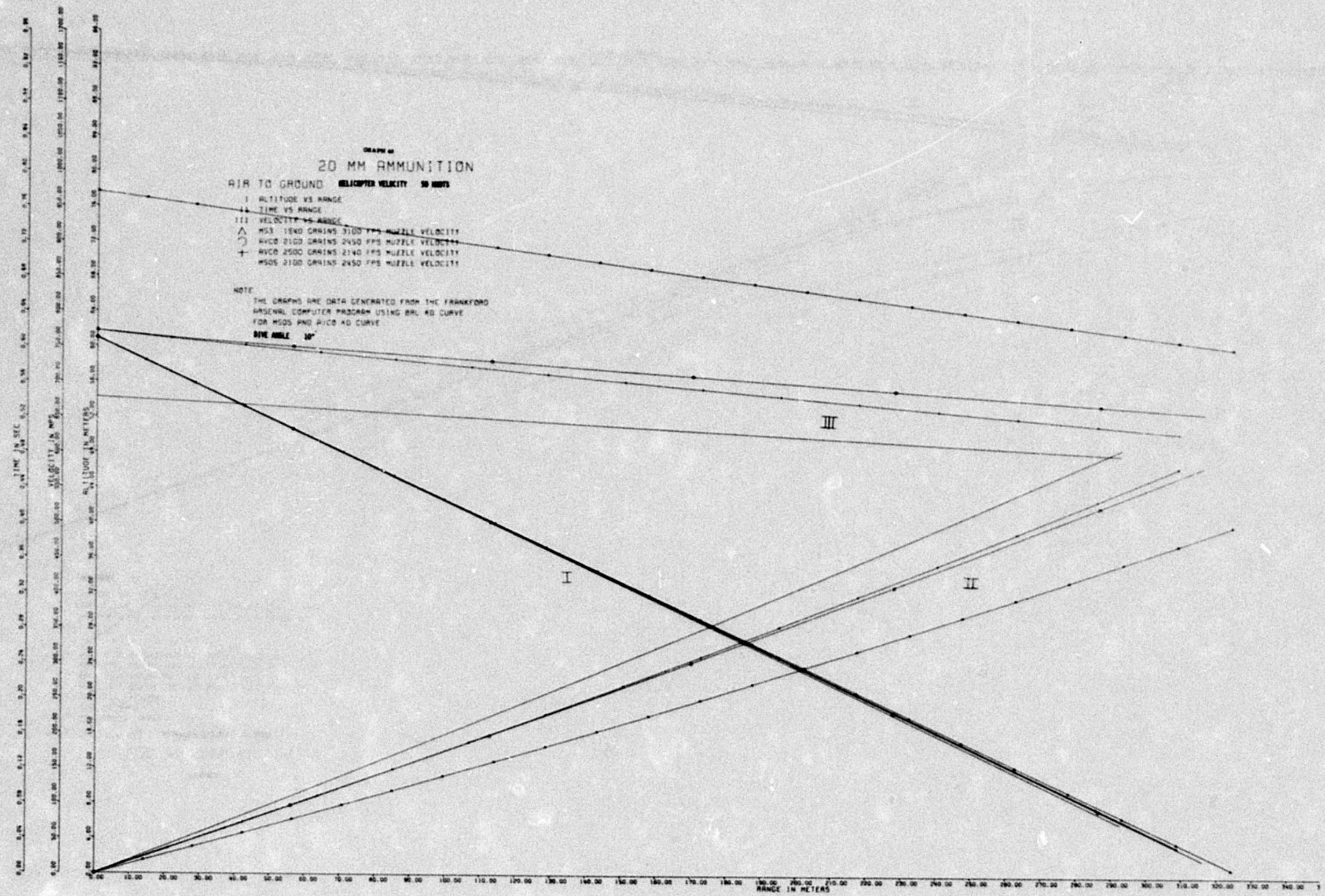

20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M57 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BAL KD CURVE FOR M505 AND AVCO KD CURVE
III
I
III
II
RANGE IN METERS


20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M505 AND AVCO KD CURVE
I
II
III
RANGE IN METERS

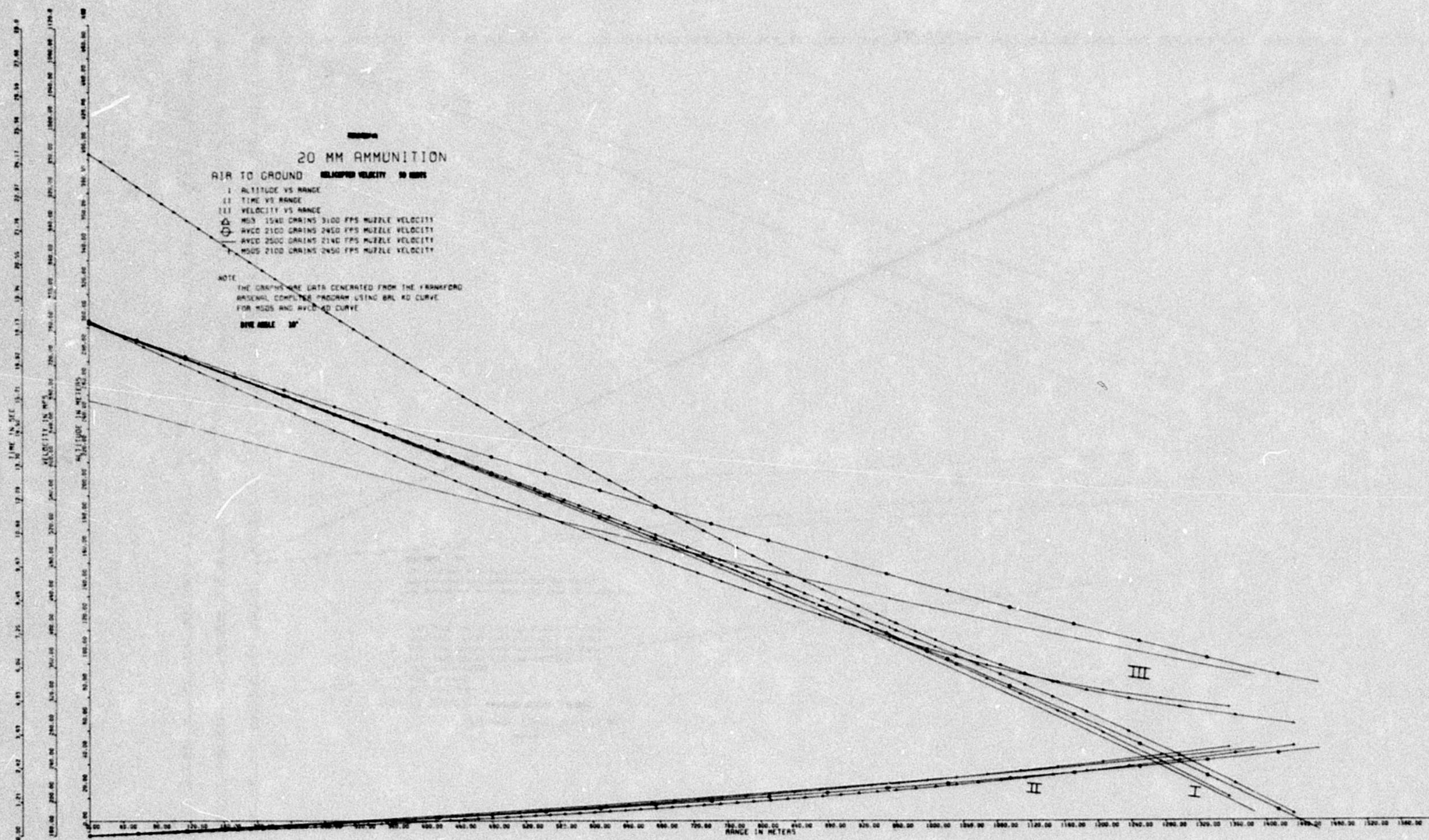

20 MM AMMUNITION
AIR TO GROUND HELICOPTER VELOCITY 0
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
GRAINS 3100 FPS MUZZLE VELOCITY
AVCO GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS MUZZLE VELOCITY
MSOS 2100 GRAINS 2450 FPS MUZZLE
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR MSOS AND AVCO KD CURVE
DIVE ANGLE 45°
I
II
III
RANGE IN METERS
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC


20 MM AMMUNITION
AIR TO GROUND

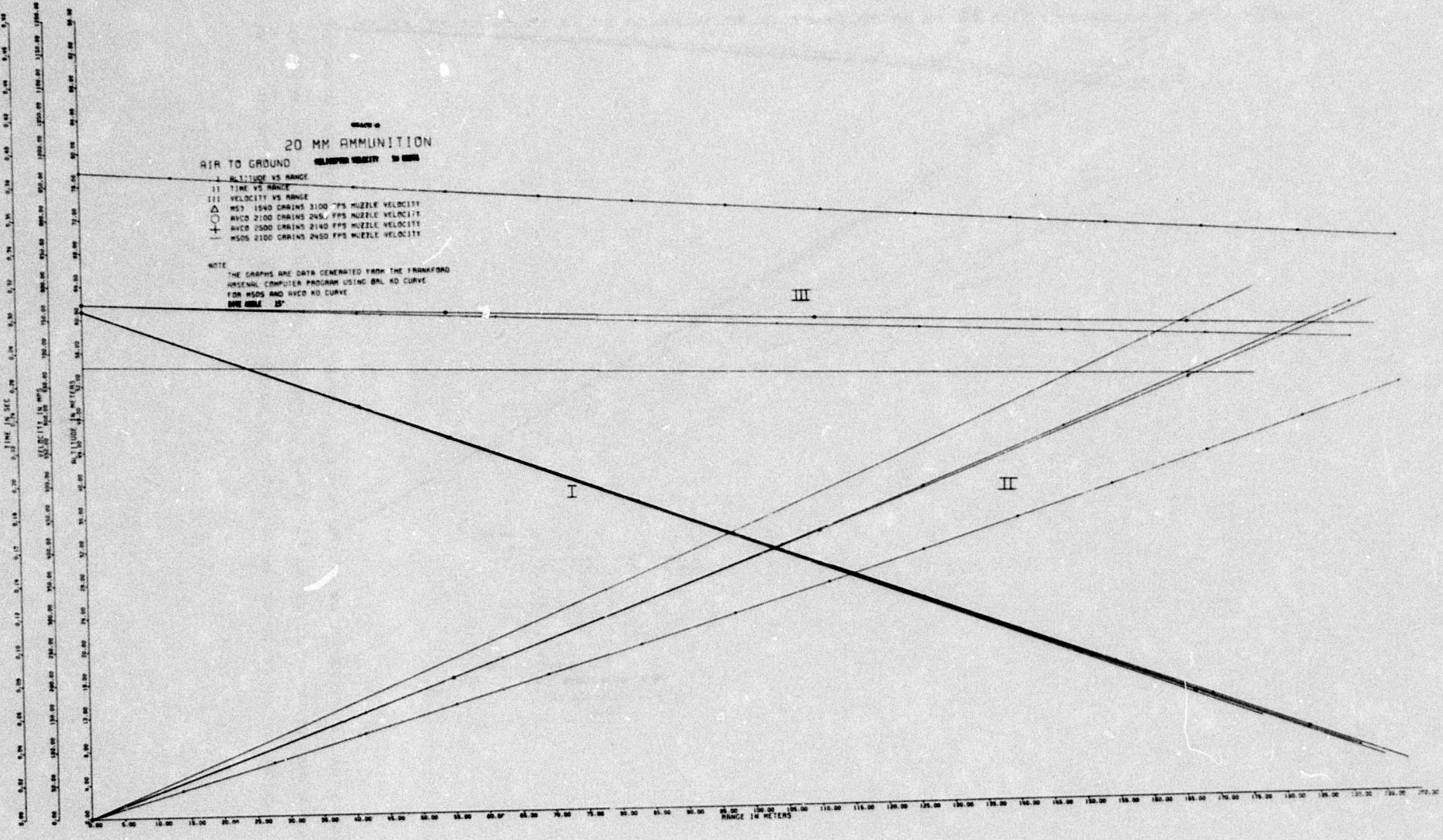

20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM
DIVE ANGLE 5°
RANGE IN METERS
I
II
III

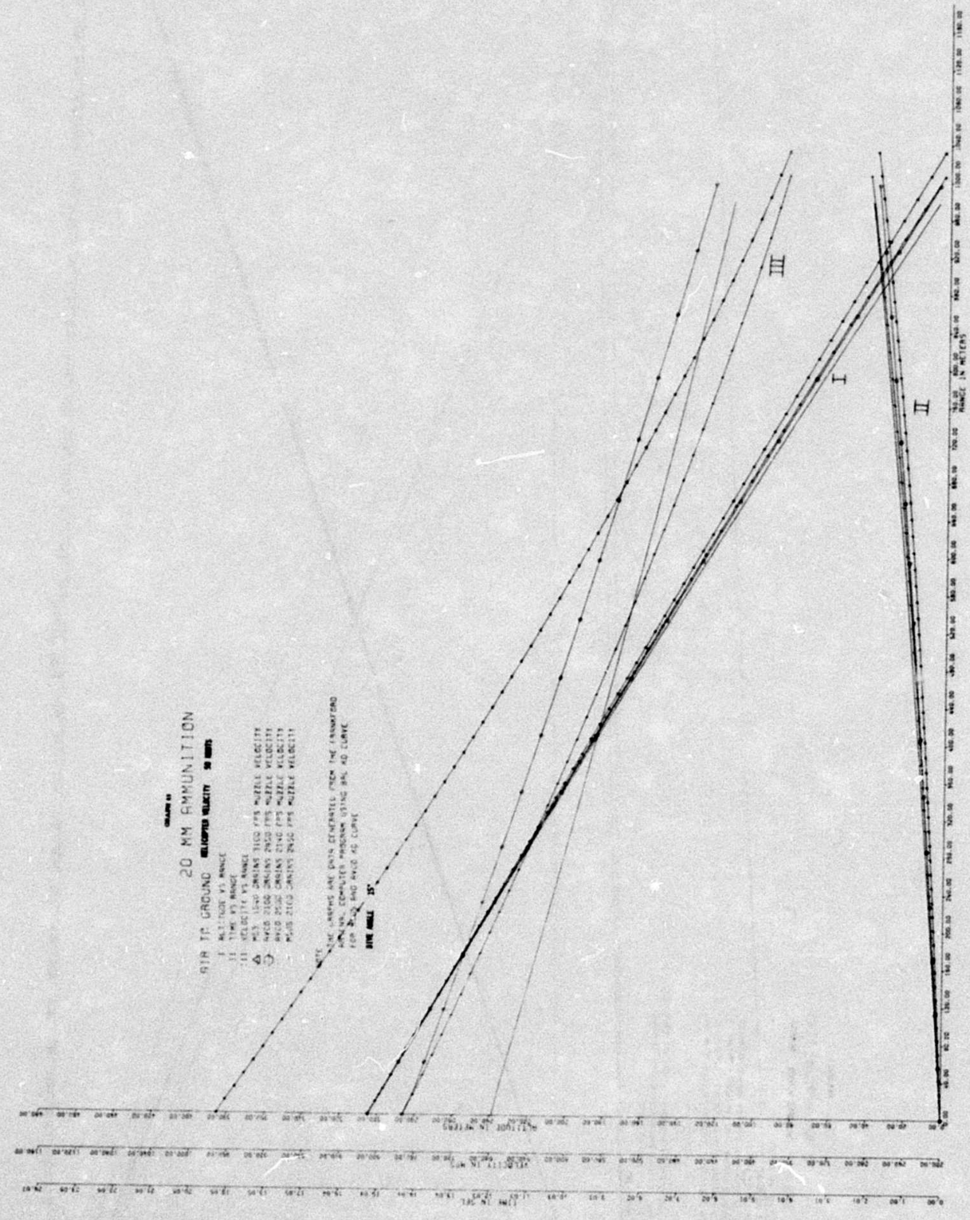


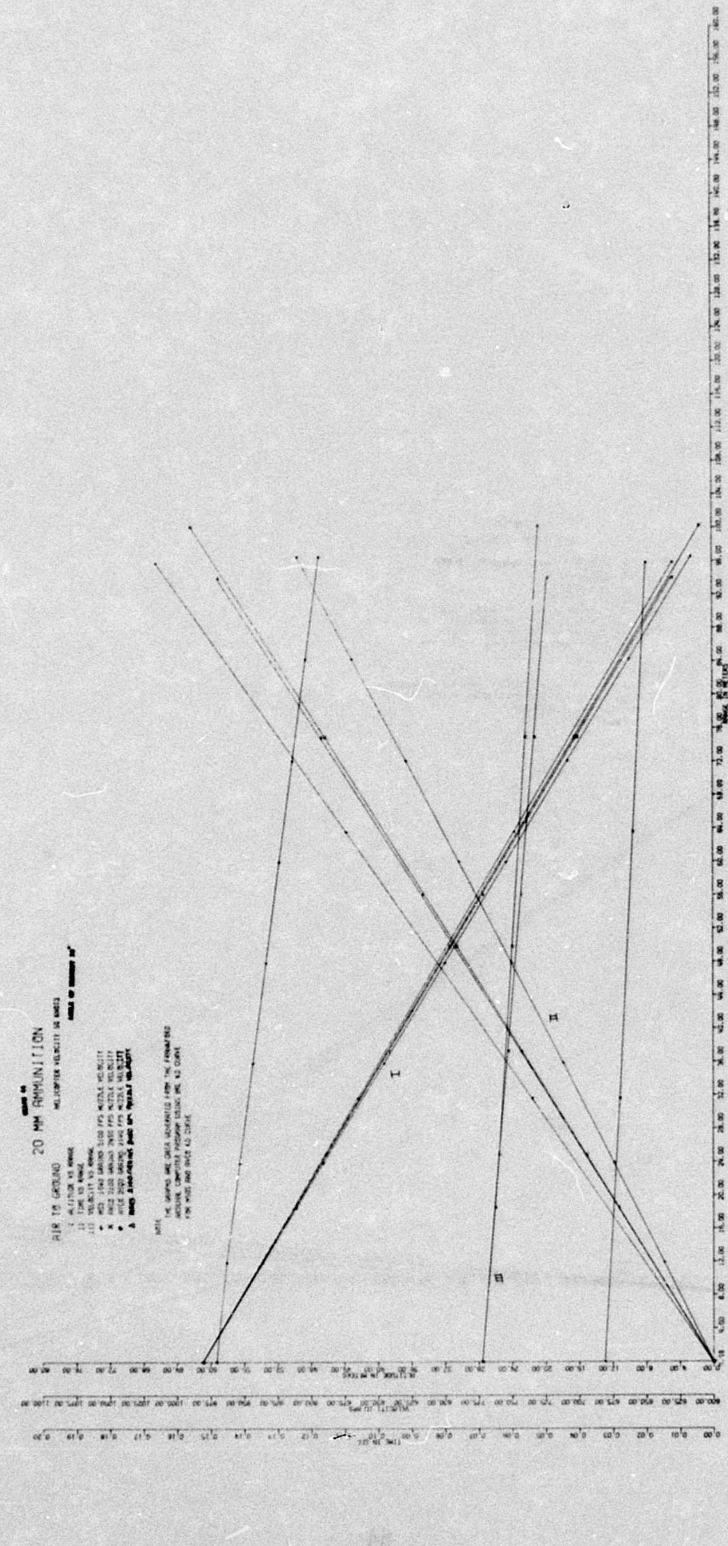
GRAPH 60
20 MM AMMUNITION
AIR TO GROUND HELICOPTER VELOCITY 50 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M505 AND AVCO KD CURVE
DIVE ANGLE 10°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS
I
II
III



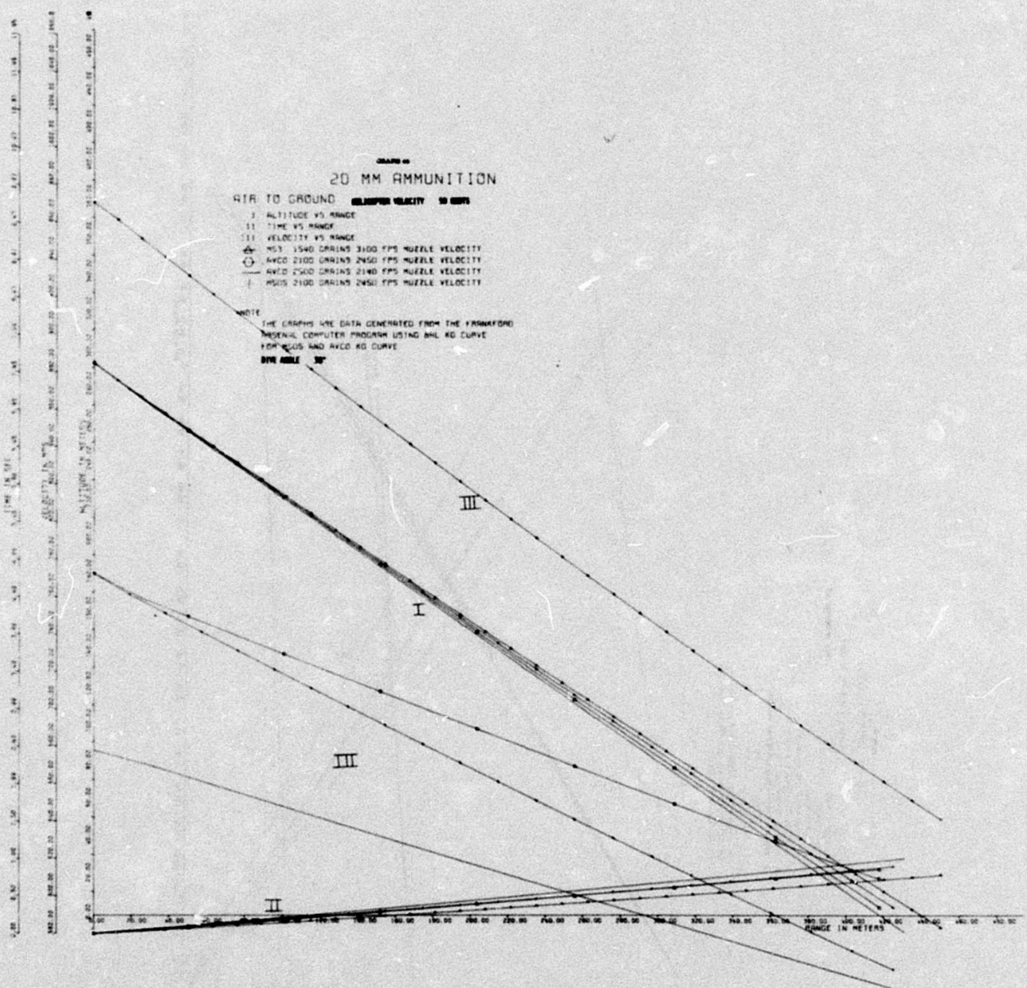
20 MM AMMUNITION
AIR TO GROUND HELICOPTER VELOCITY 50 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M505 AND AVCO KD CURVE
DIVE ANGLE 10°
RANGE IN METERS
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC
I
II
III

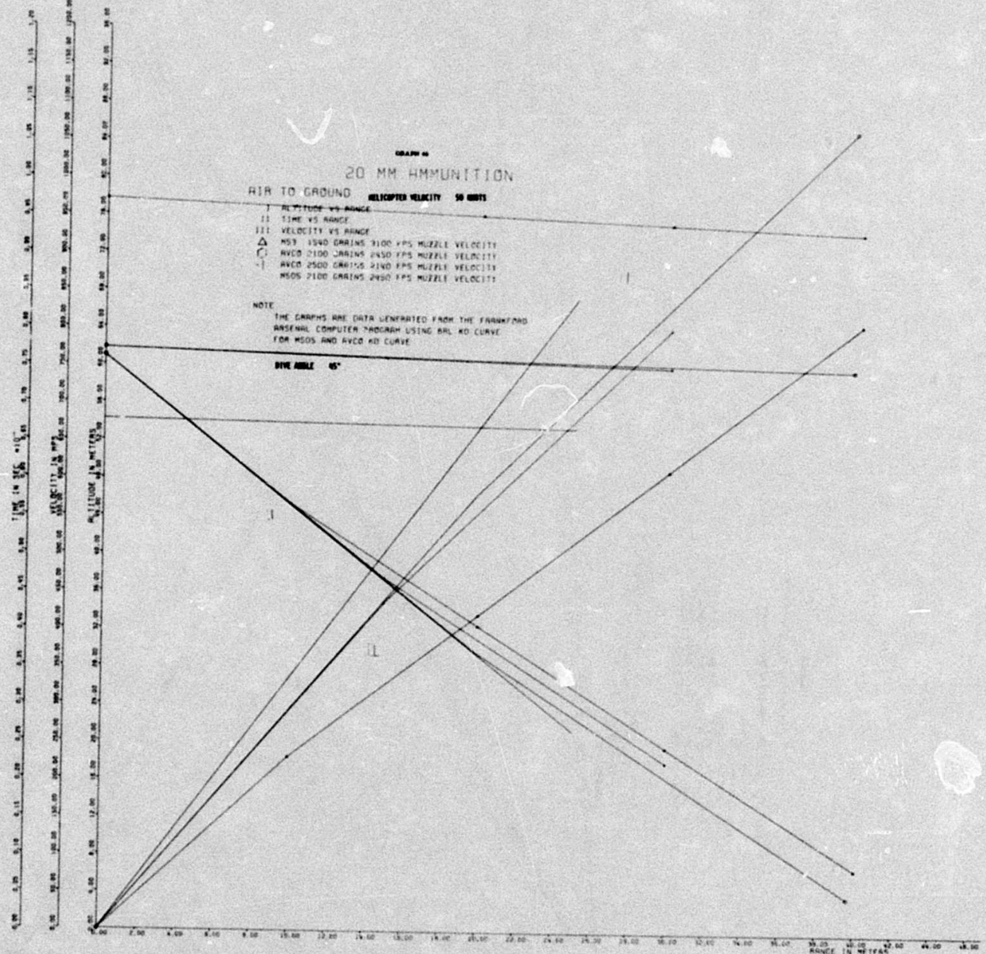

20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M505 AND AVCO KD CURVE
I
II
III
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS


20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
I
II
III
RANGE IN METERS

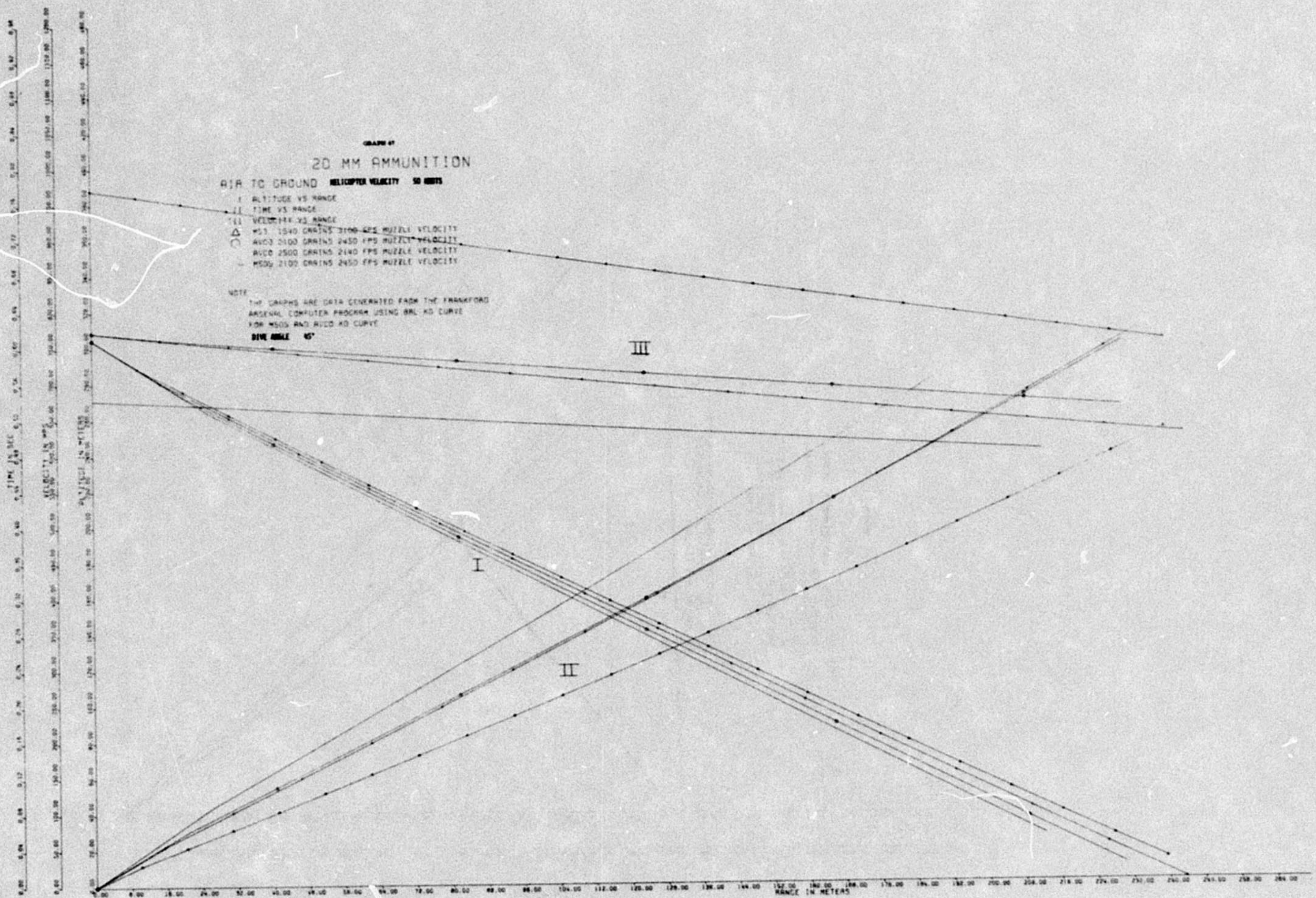


AIR TO GROUND
20 MM AMMUNITION
I
II
III
NOTE

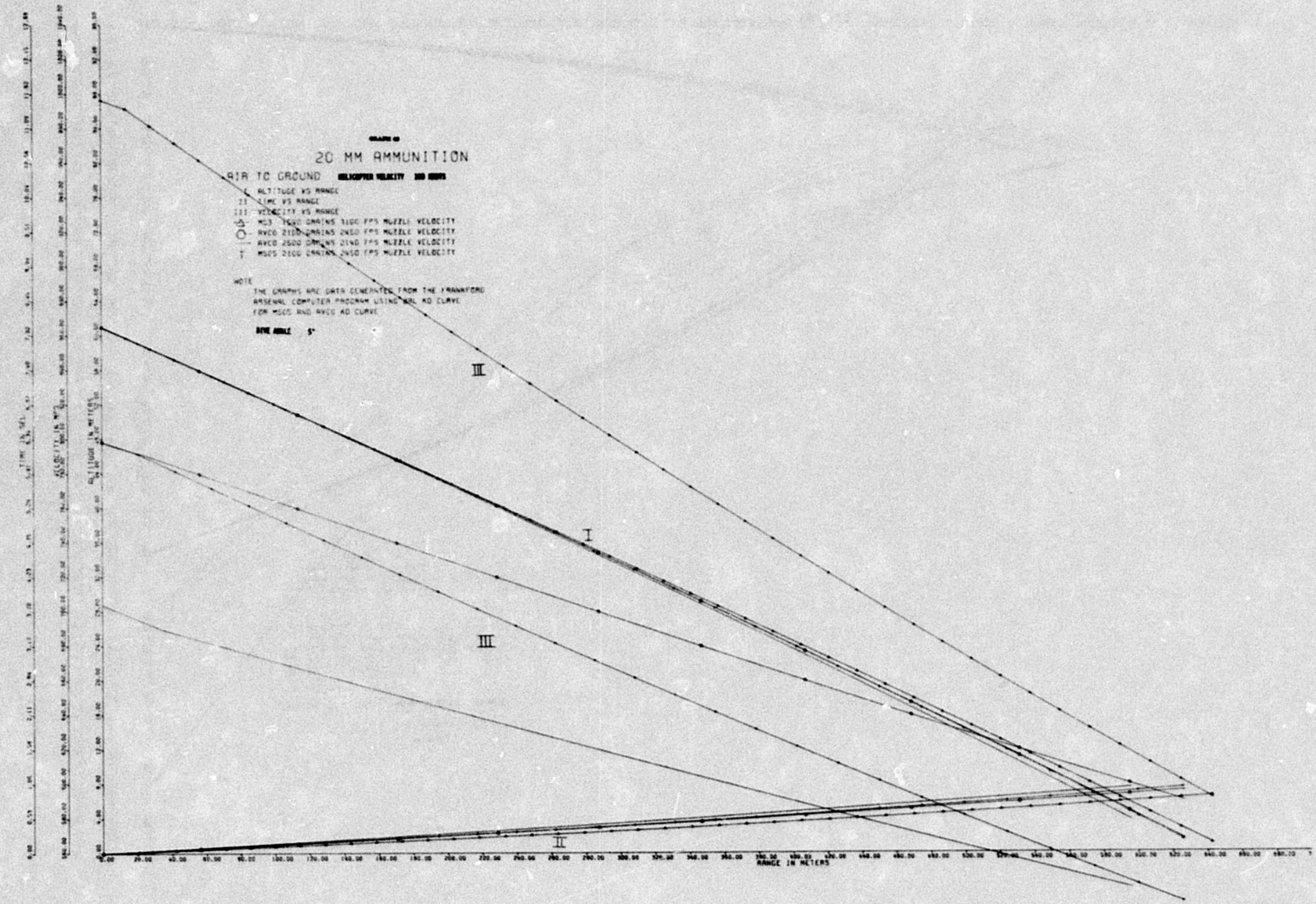

20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M505 AND AVCO KD CURVE
III
I
III
II
RANGE IN METERS

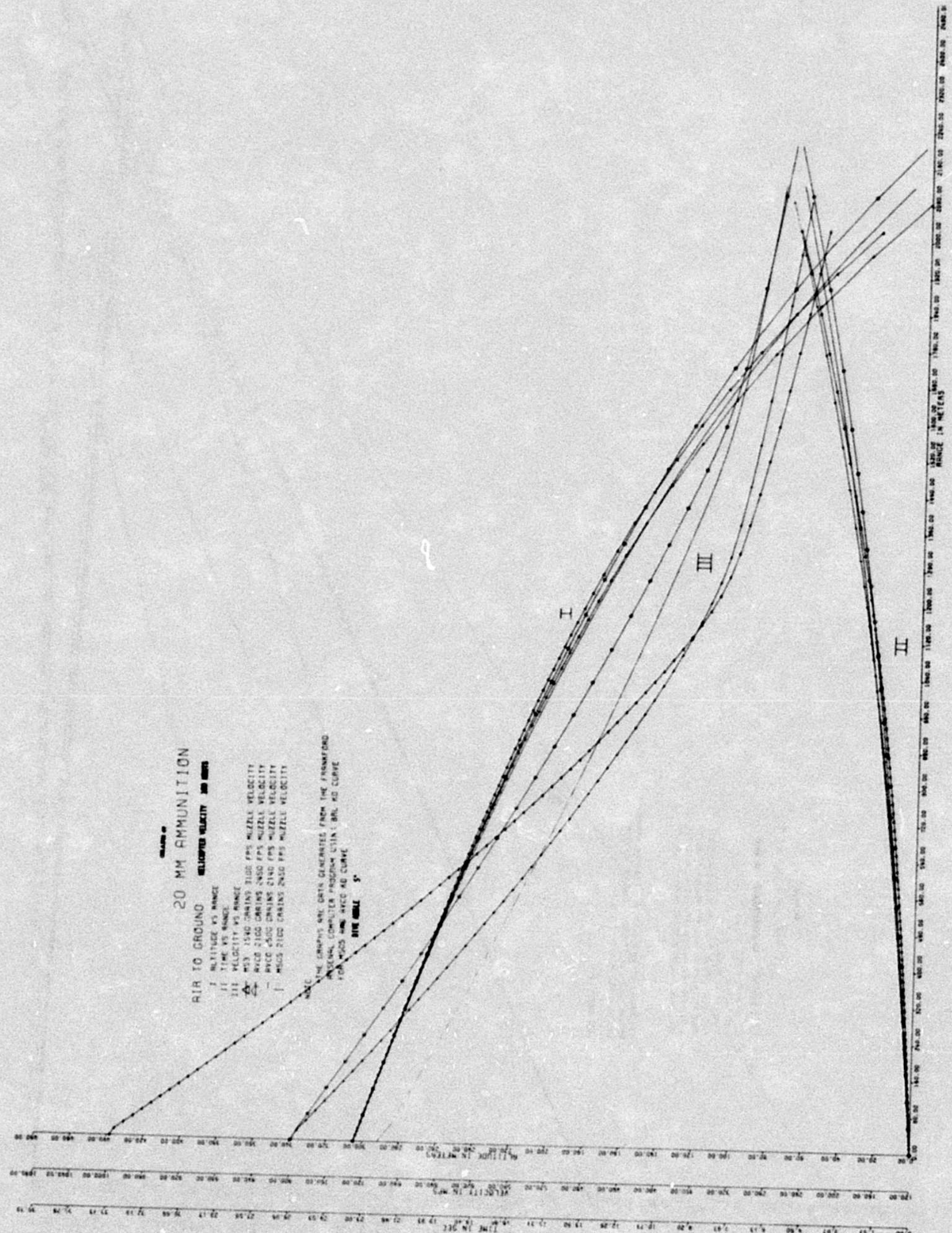


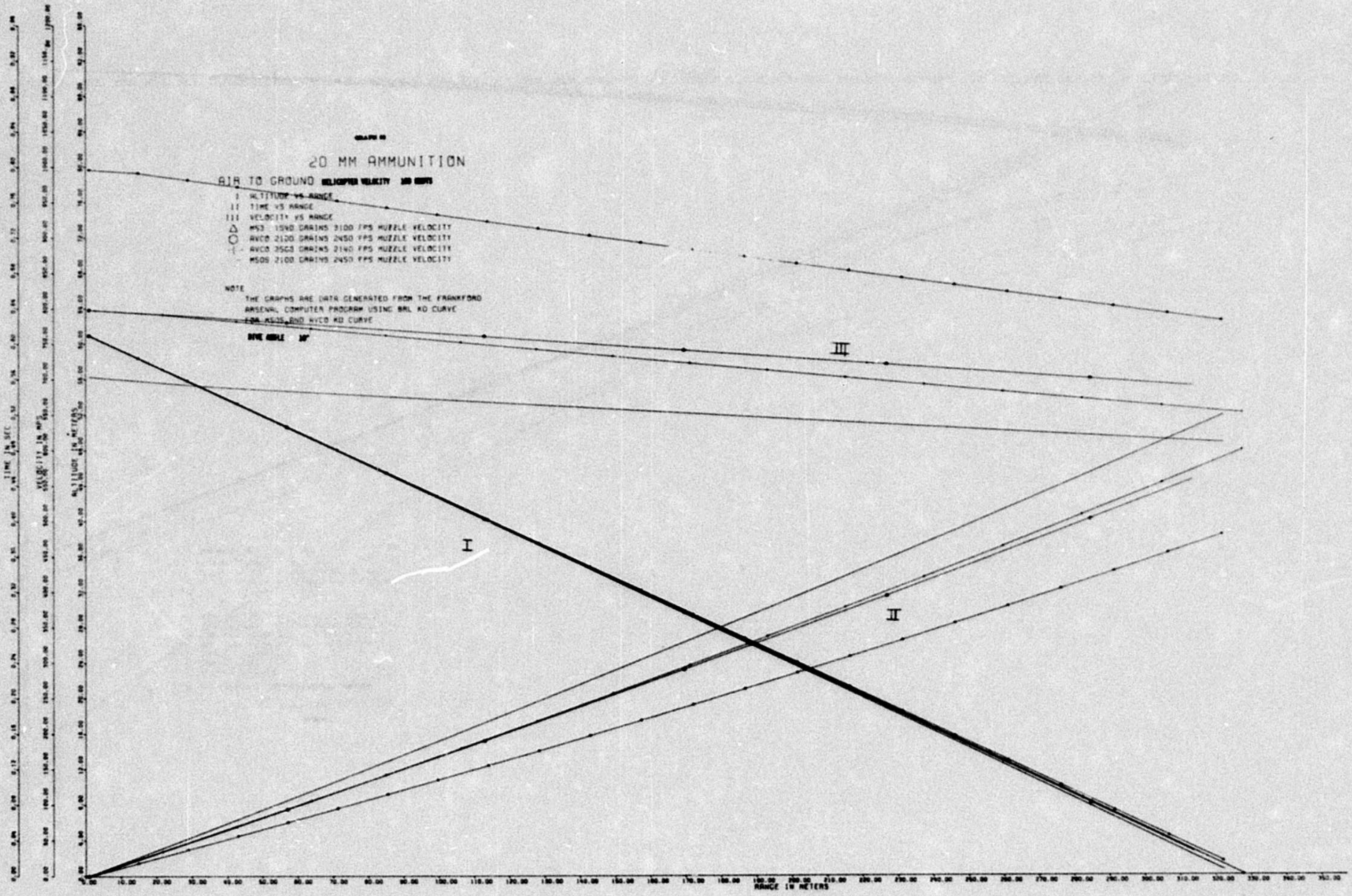
20 MM AMMUNITION
AIR TO GROUND
HELICOPTER VELOCITY 50 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M505 AND AVCO KD CURVE
DIVE ANGLE 45°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS



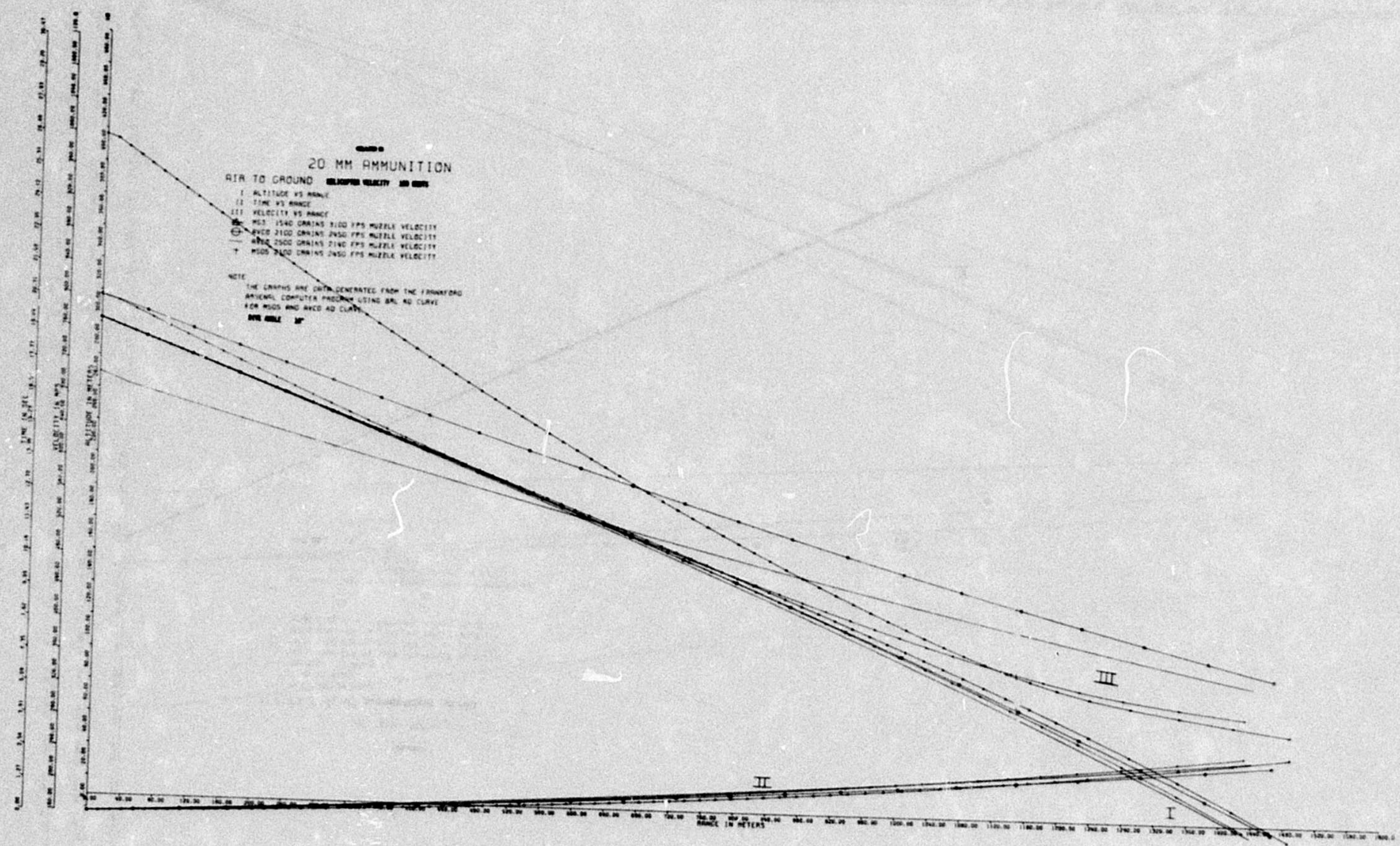
20 MM AMMUNITION
AIR TO GROUND HELICOPTER VELOCITY 50 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M50 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M505 AND AVCO KD CURVE
DIVE ANGLE 45°
I
II
III
RANGE IN METERS
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS

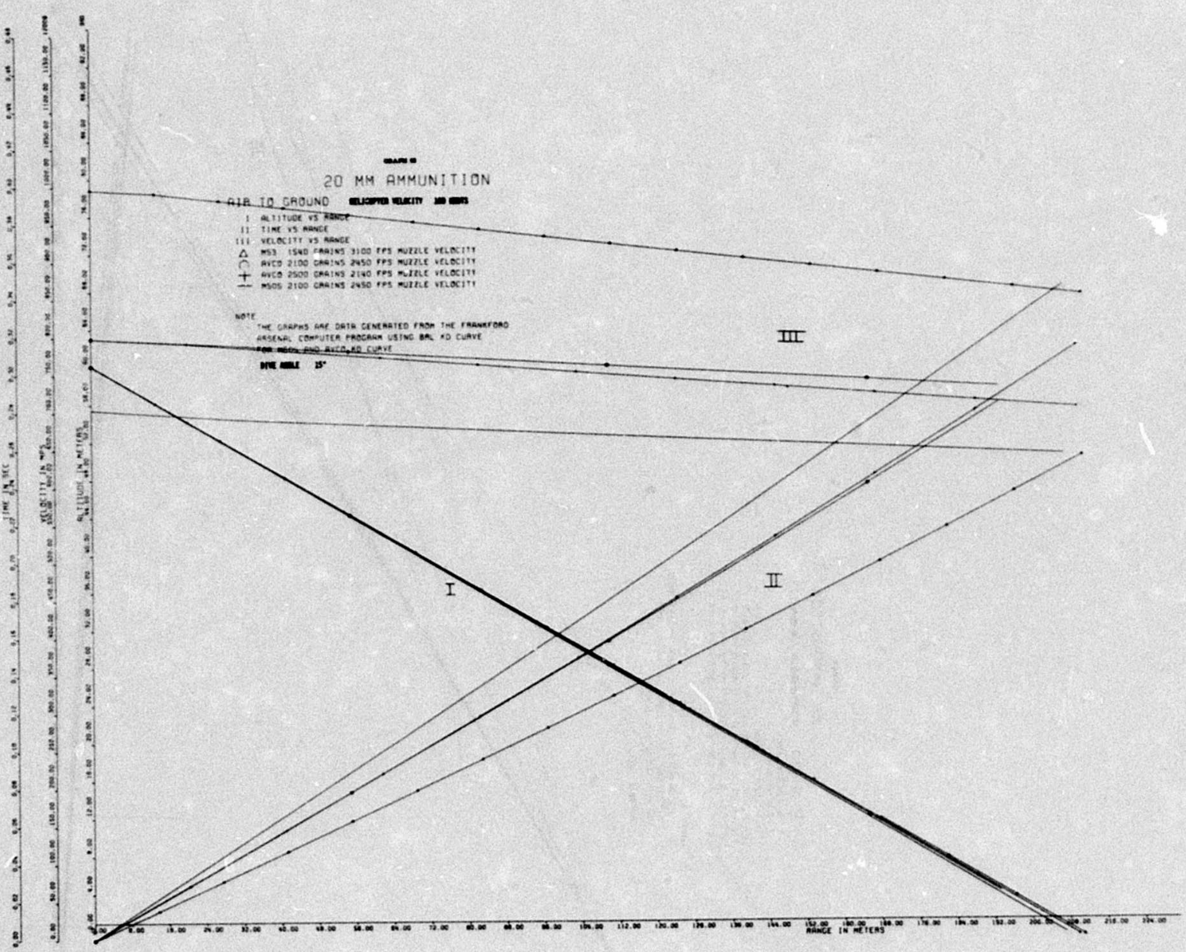

20 MM AMMUNITION
AIR TO GROUND HELICOPTER VELOCITY 300 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1500 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
MS05 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR MS05 AND AVCO KD CURVE
DIVE ANGLE 5°
TIME IN SEC
VELOCITY IN M/S
ALTITUDE IN METERS
RANGE IN METERS
I
II
III
III


AIR TO GROUND
20 MM AMMUNITION
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM
KD CURVE
I
II
III
RANGE IN METERS

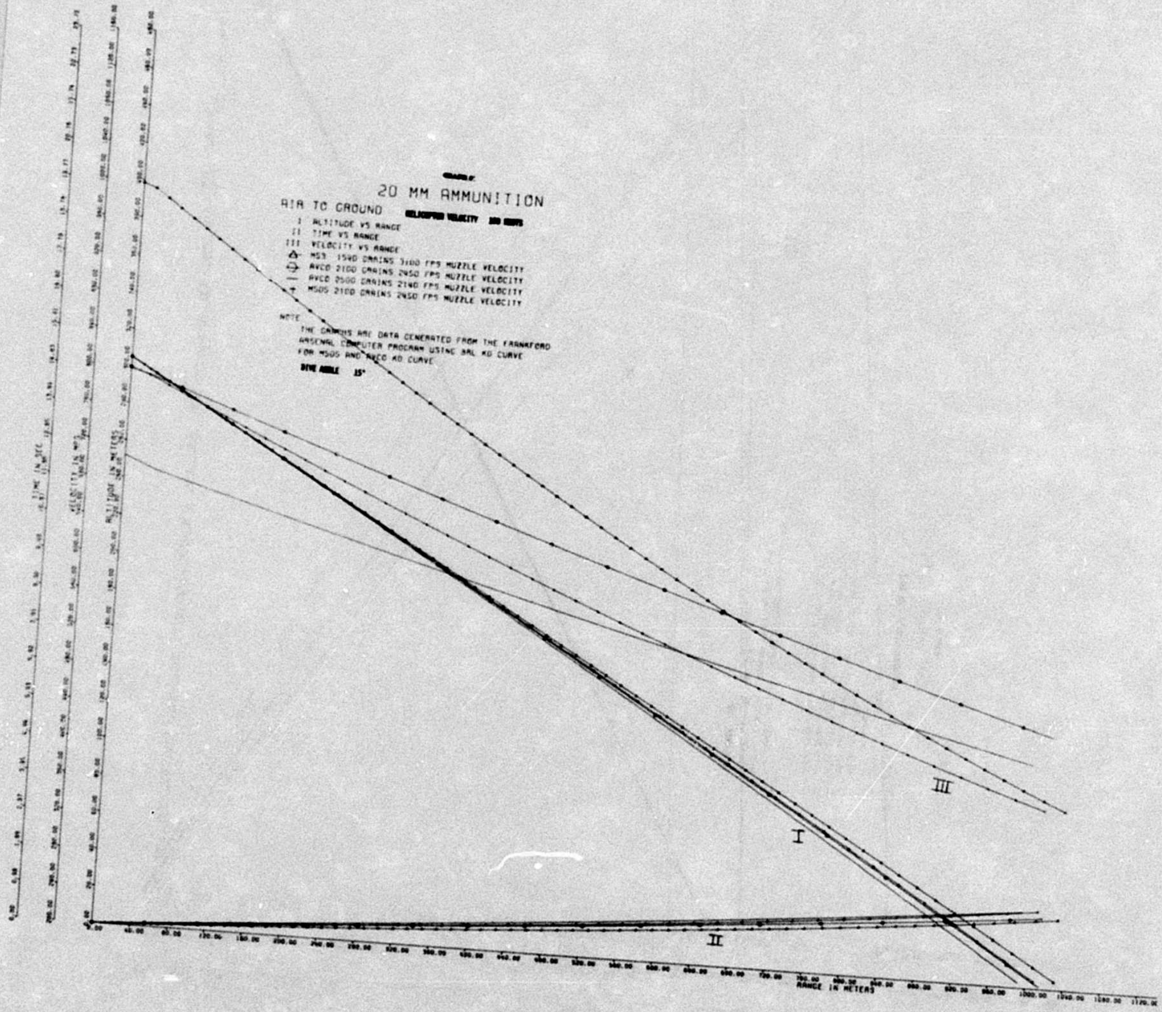


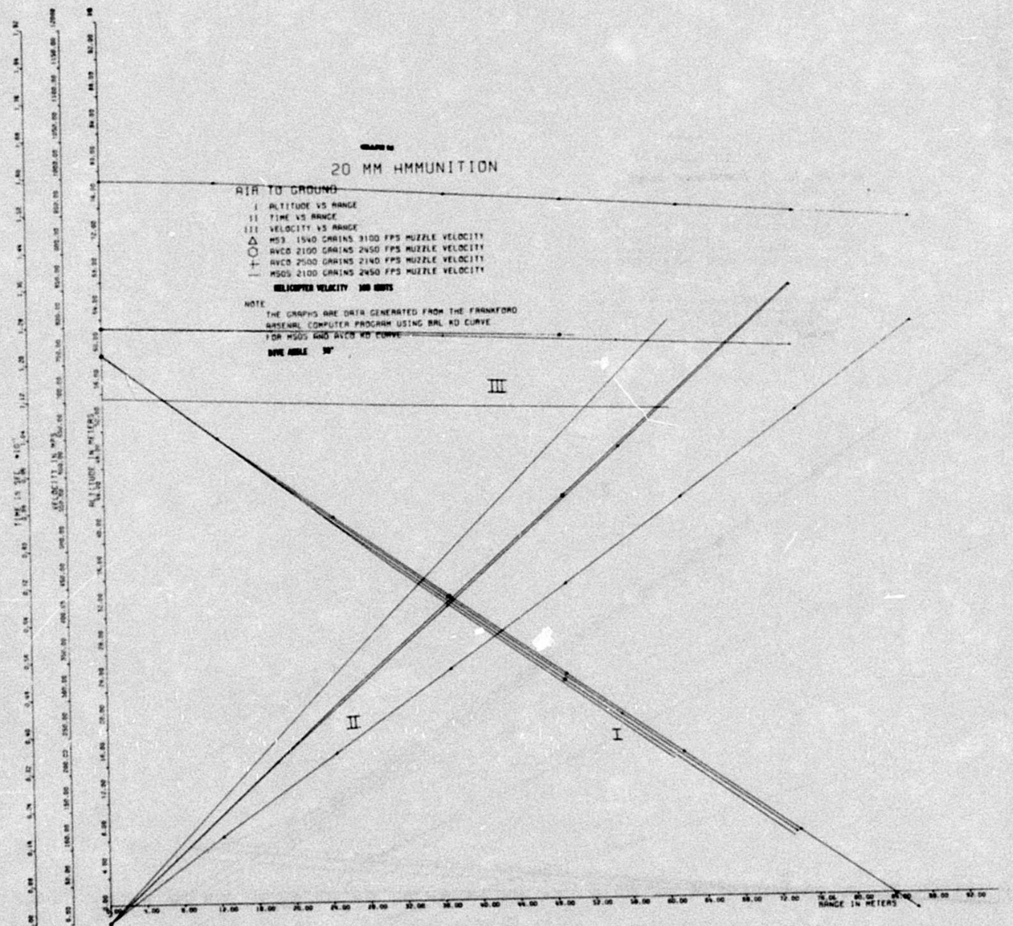
20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
△ M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
○ AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2503 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M505 AND AVCO KD CURVE
I
II
III
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS

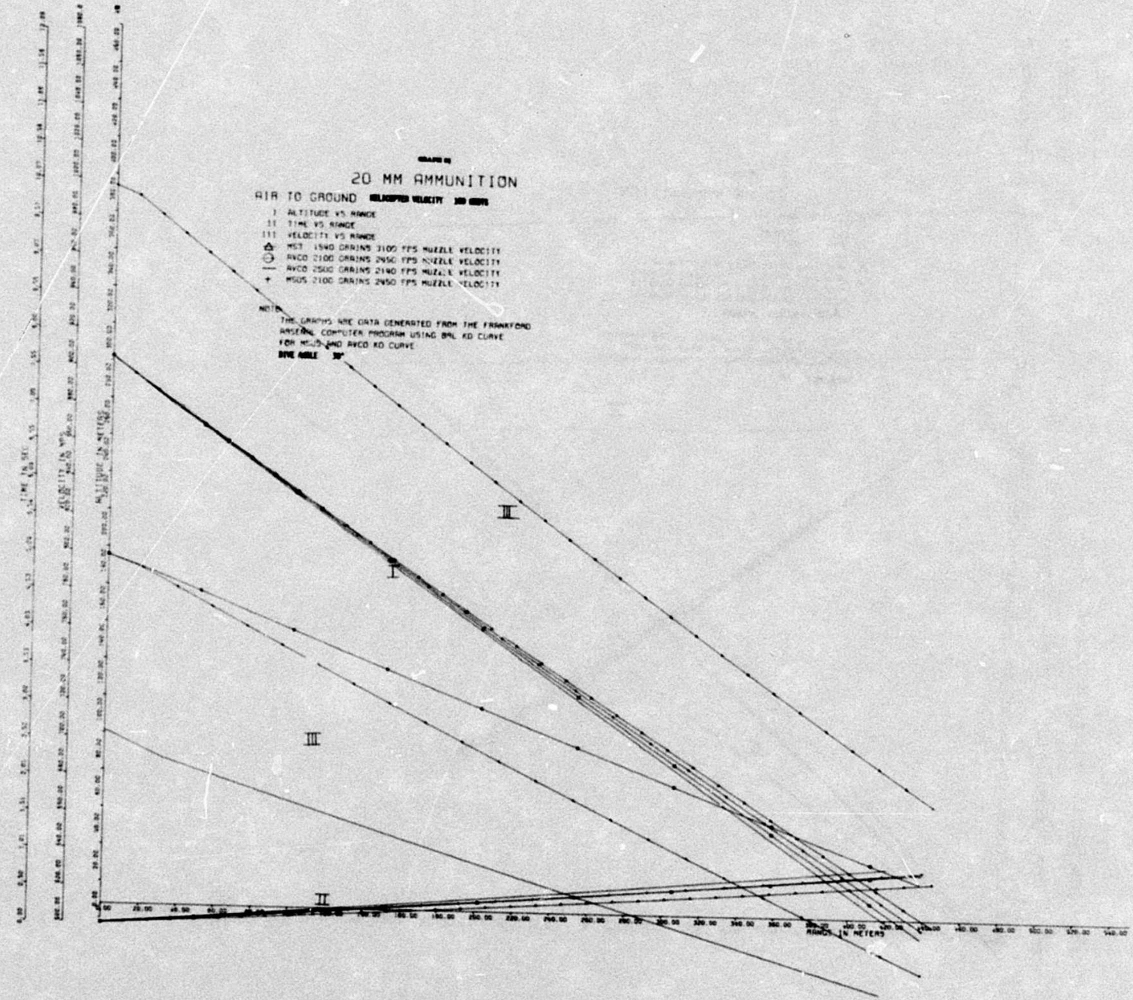

20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL AD CURVE FOR M505 AND AVCO AD CURVE
RANGE IN METERS
I
II
III

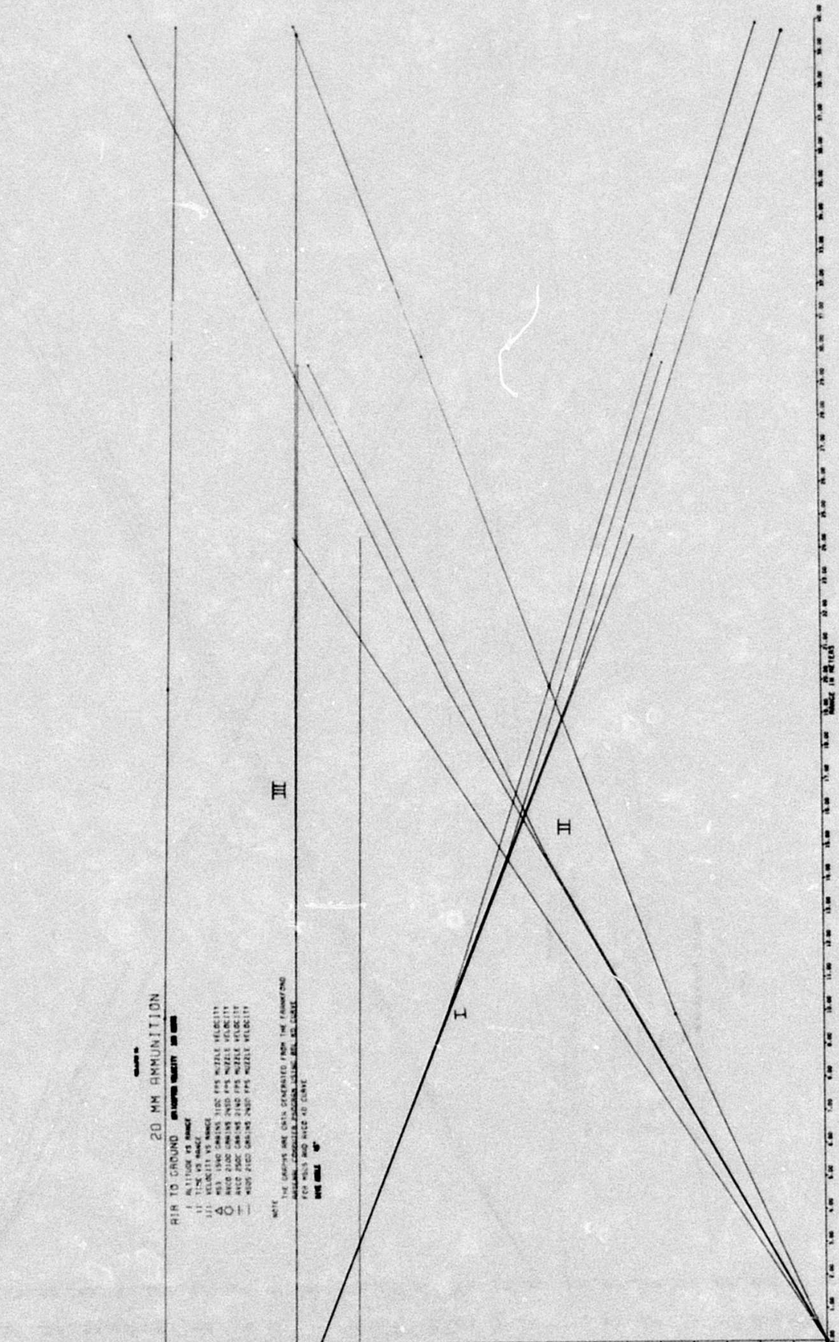


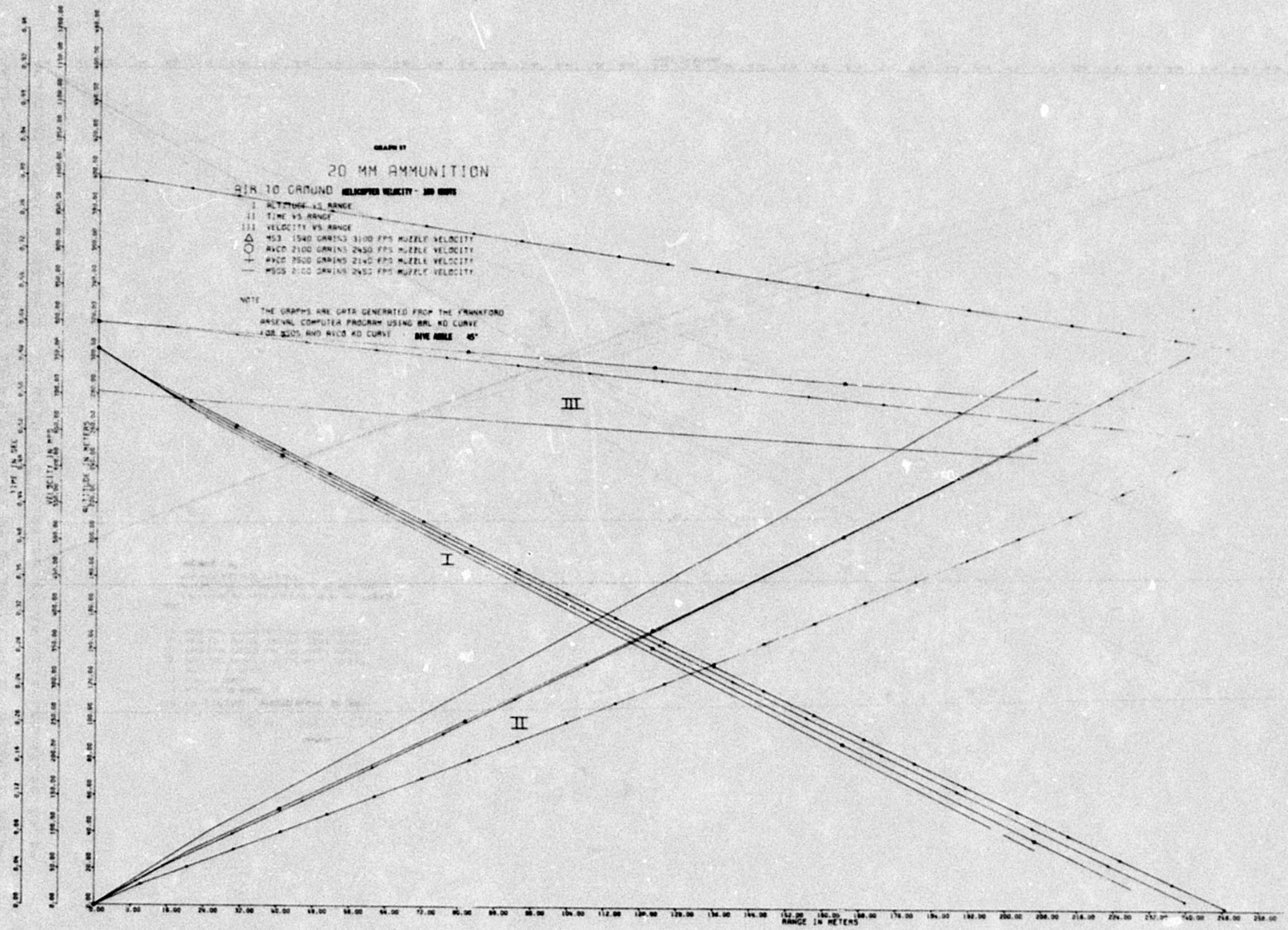
20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
15°
I
II
III
RANGE IN METERS
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC

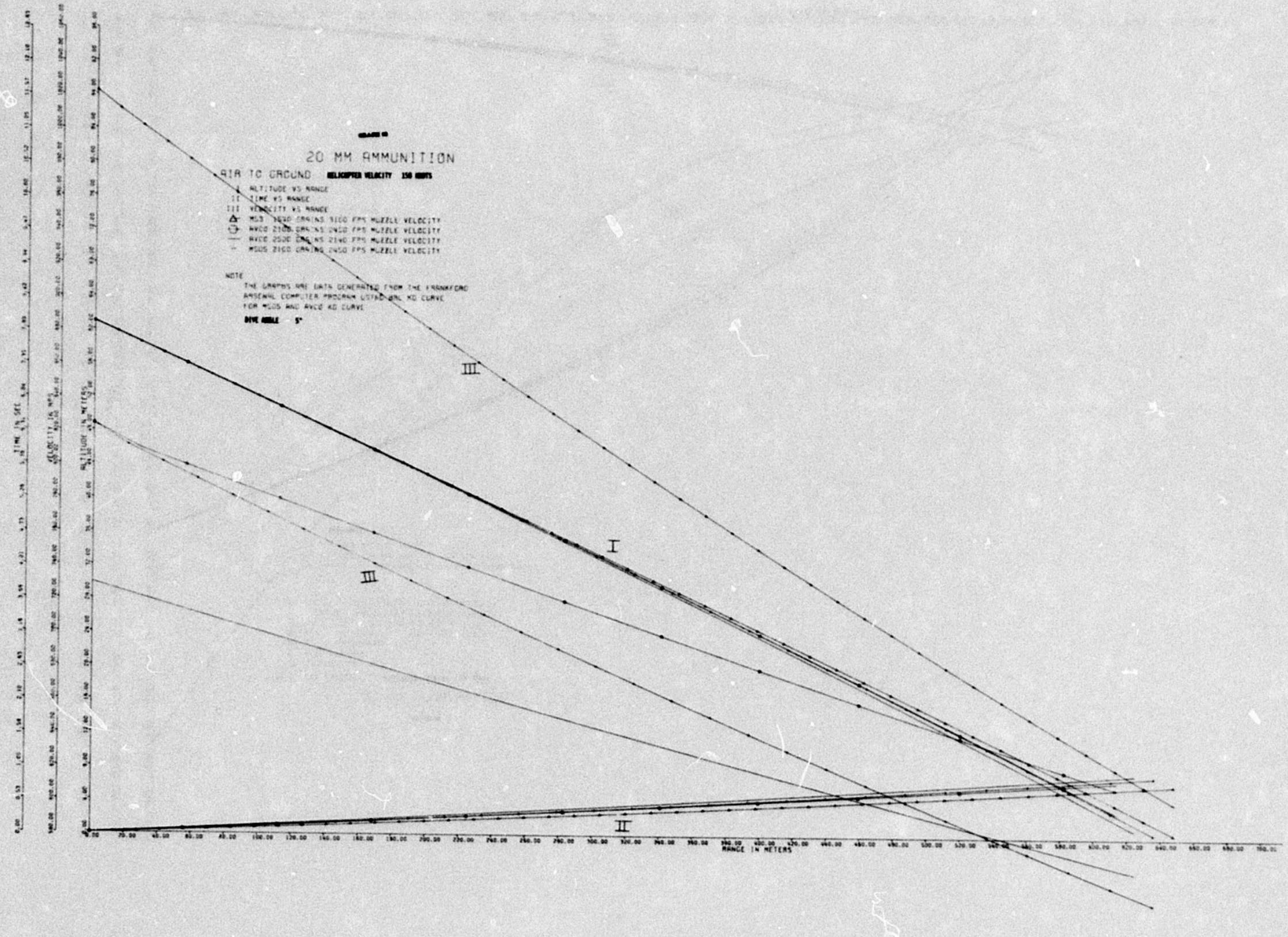

20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M505 AND AVCO KD CURVE
DIVE ANGLE 15°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS
I
II
III

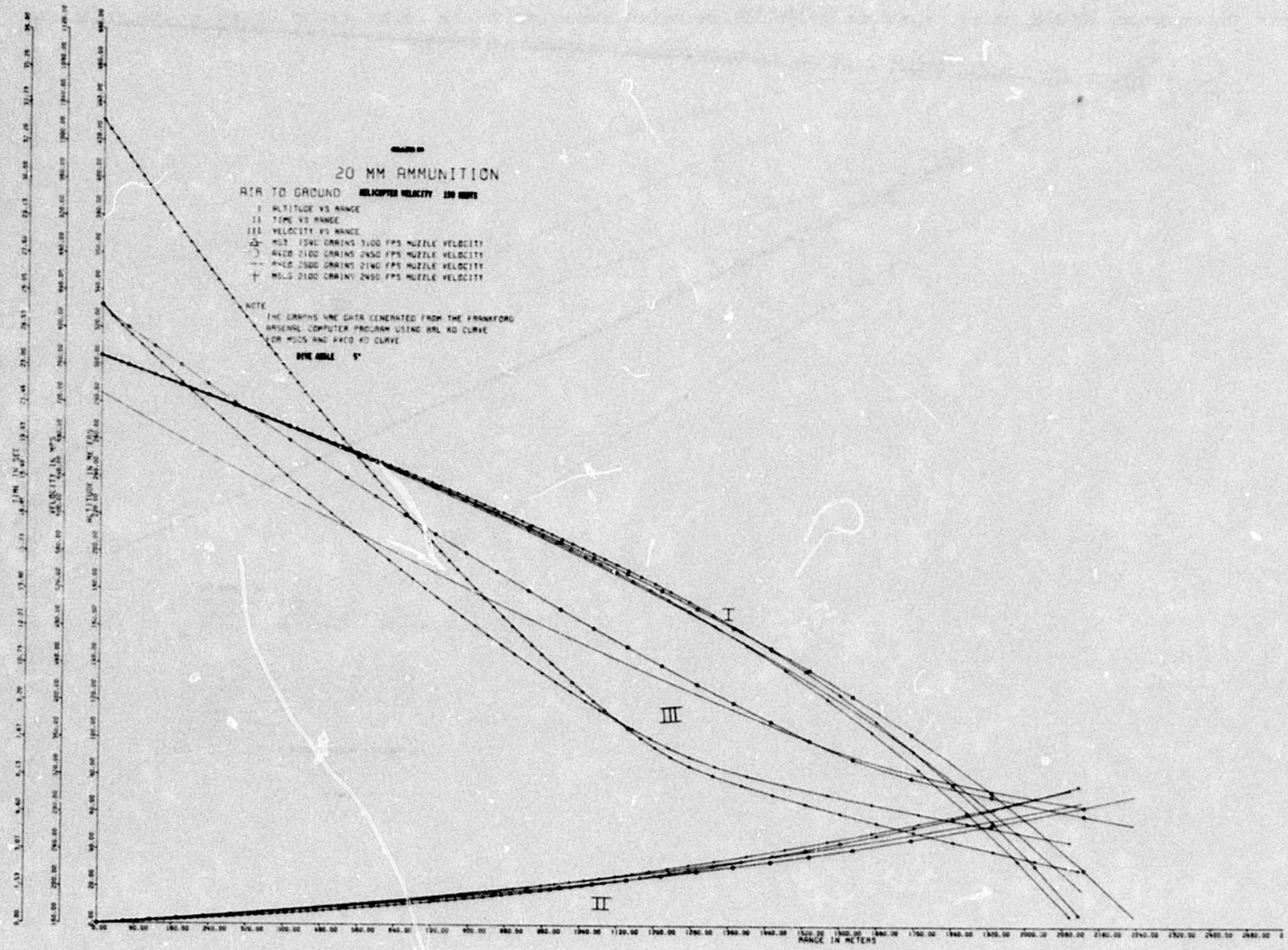

20 MM HMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
△ M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
○ AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
+ AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
— M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M505 AND AVCO KD CURVE
III
II
I
RANGE IN METERS

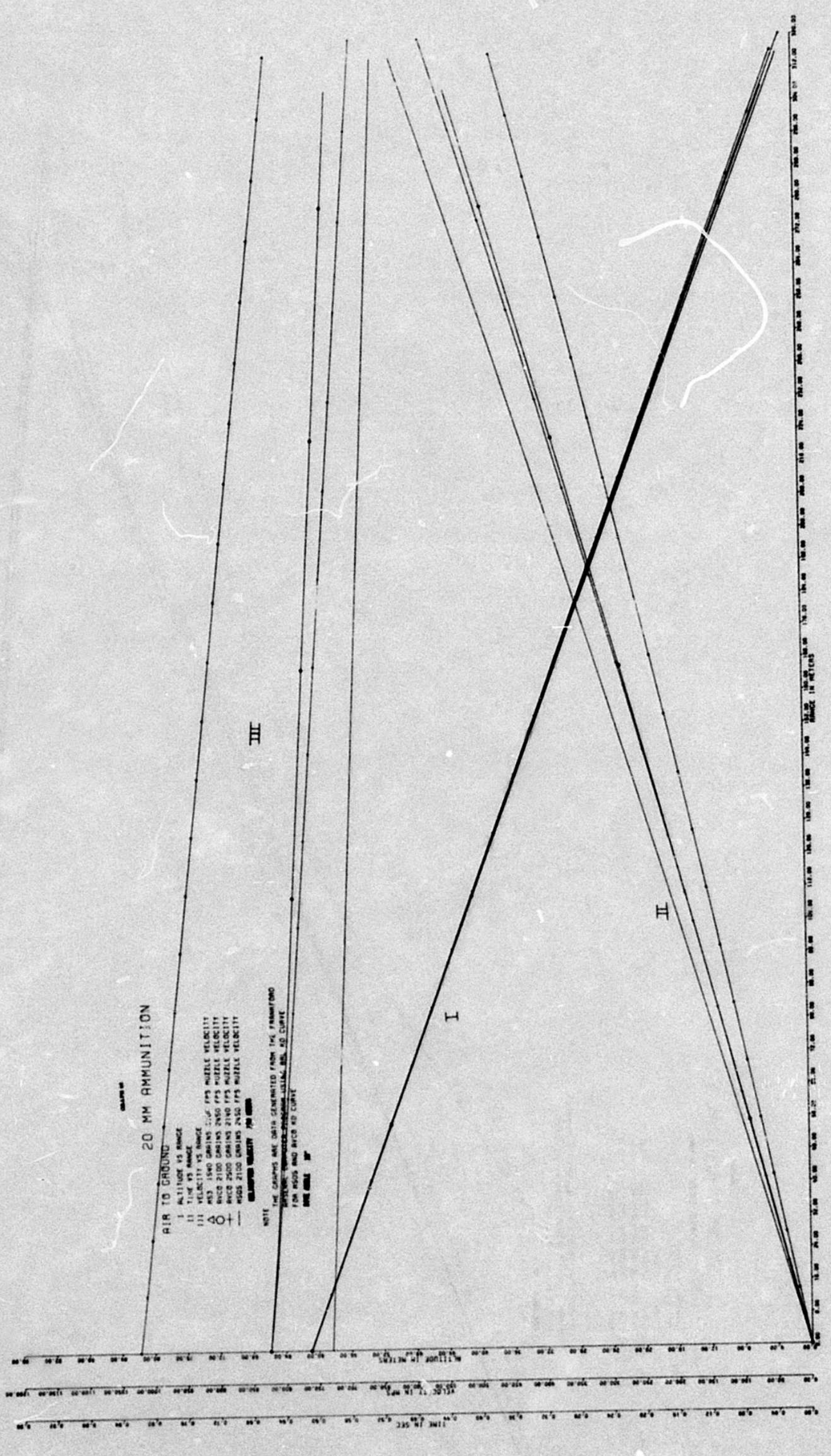

20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
MST 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
MSDS 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR MSDS AND AVCO KD CURVE
DIVE ANGLE 30°
I
II
III
III
RANGE IN METERS

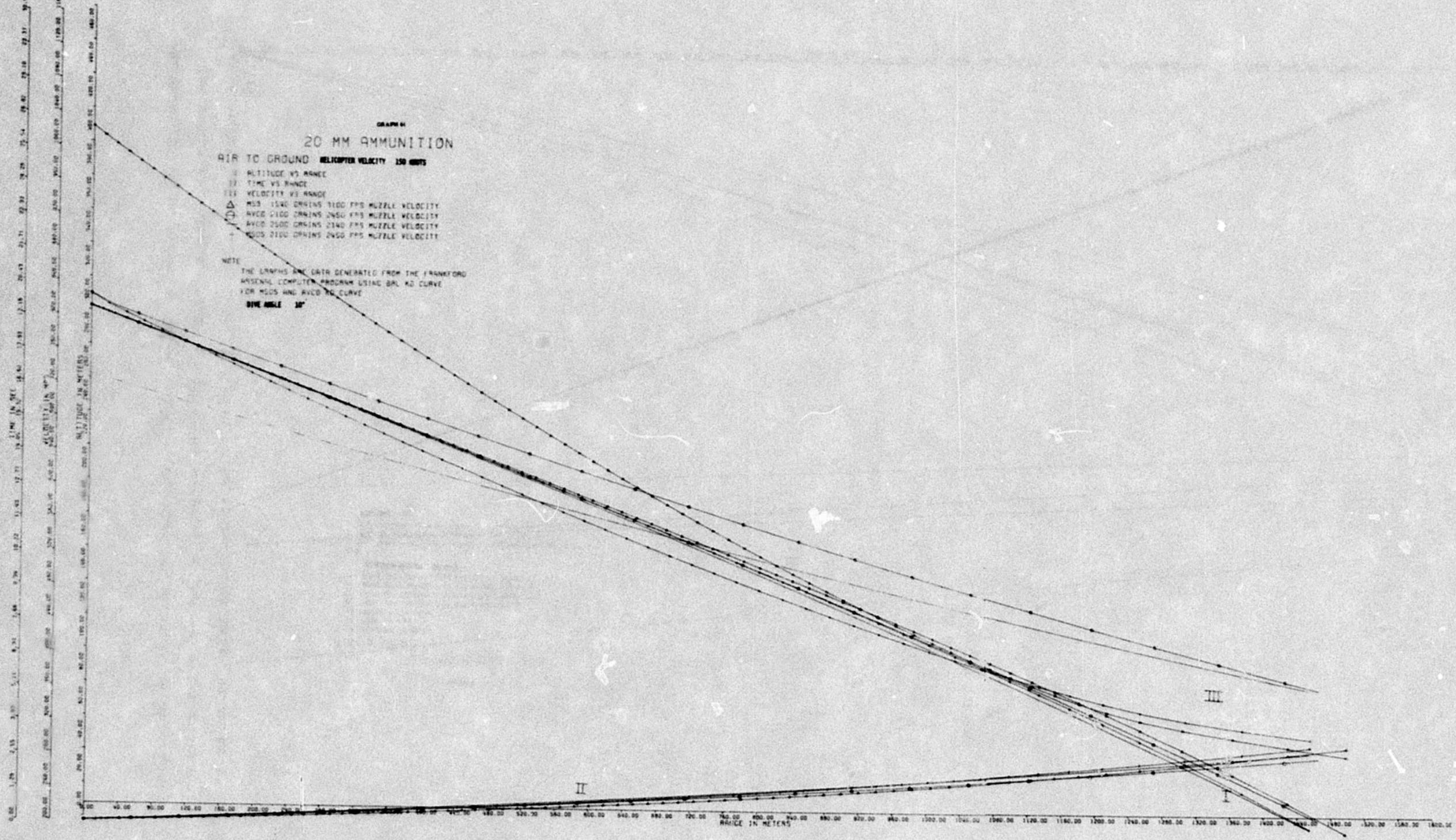

20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M505 AND AVCO KD CURVE
I
II
III
RANGE IN METERS
ALTITUDE IN METERS

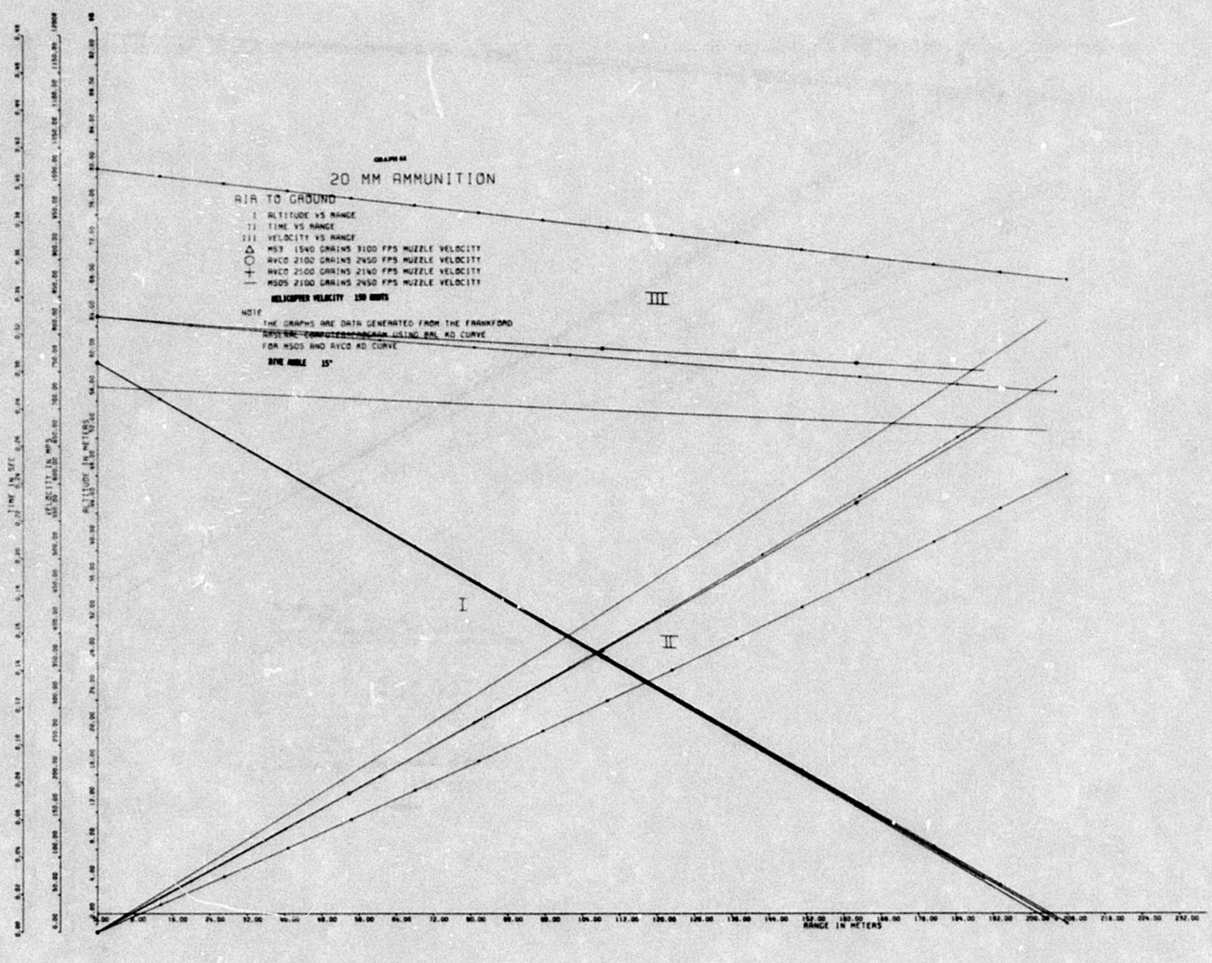

20 MM AMMUNITION
AIR TO GROUND HELICOPTER VELOCITY - 300 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M505 AND AVCO KD CURVE
DIVE ANGLE 45°
RANGE IN METERS
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
I
II
III


20 MM AMMUNITION
AIR TO GROUND HELICOPTER VELOCITY 150 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
AVCO 2100 GRAINS 2400 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM
FOR AND AVCO KD CURVE
DIVE ANGLE 5°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS
I
II
III
III

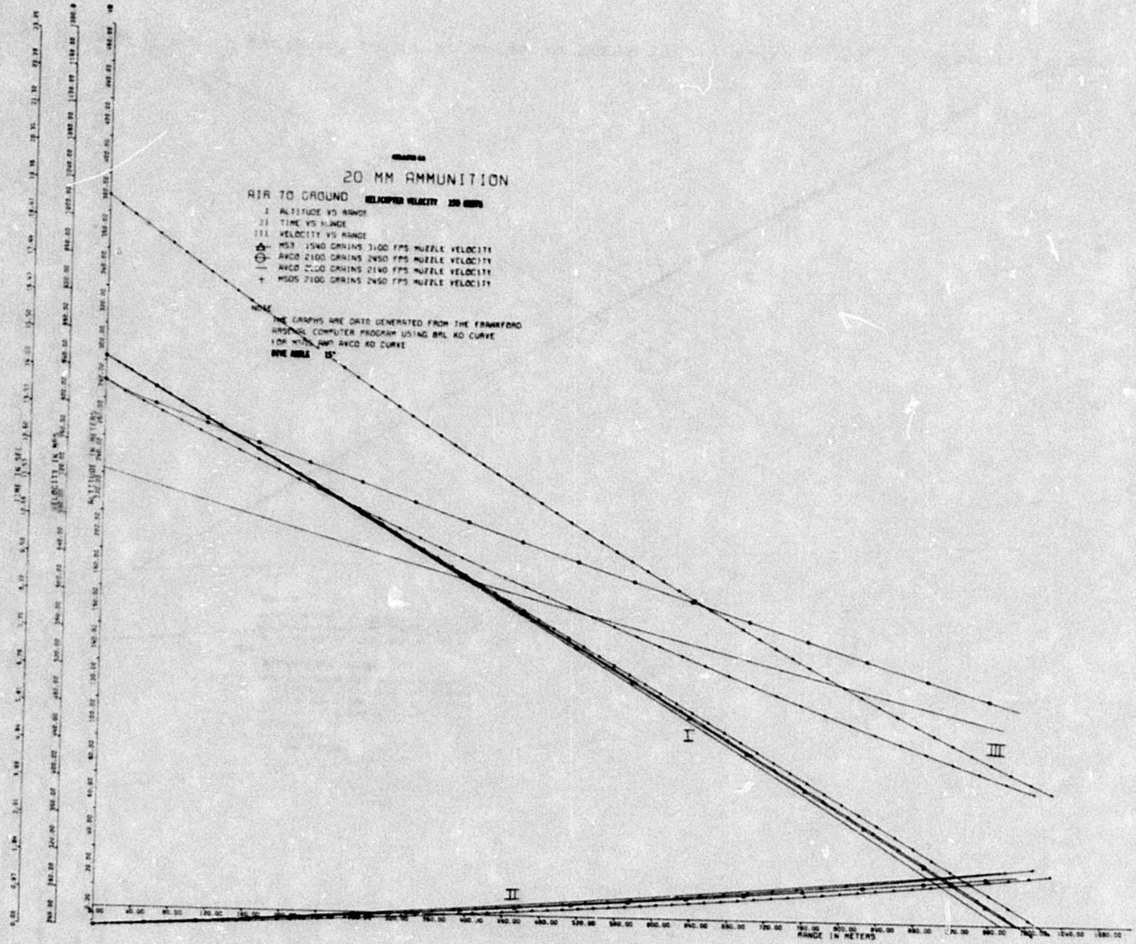

20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
DIVE ANGLE 5°
RANGE IN METERS
I
II
III

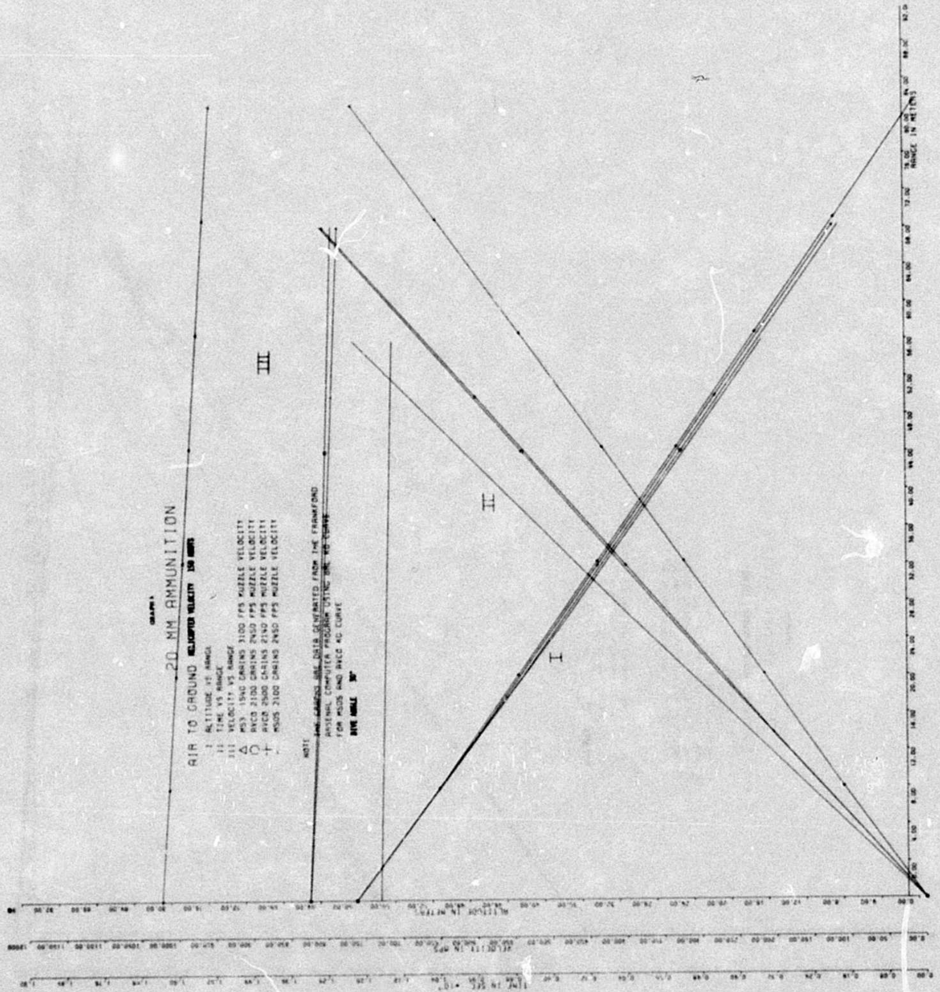

20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
AVCO 2100 GRAINS 2650 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
MSOS 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
FOR MSOS AND AVCO KD CURVE
I
II
III
RANGE IN METERS


20 MM AMMUNITION
AIR TO GROUND HELICOPTER VELOCITY 150 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2340 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M505 AND AVCO KD CURVE
DIVE ANGLE 10°
RANGE IN METERS
ALTITUDE IN METERS
TIME IN SEC
I
II
III

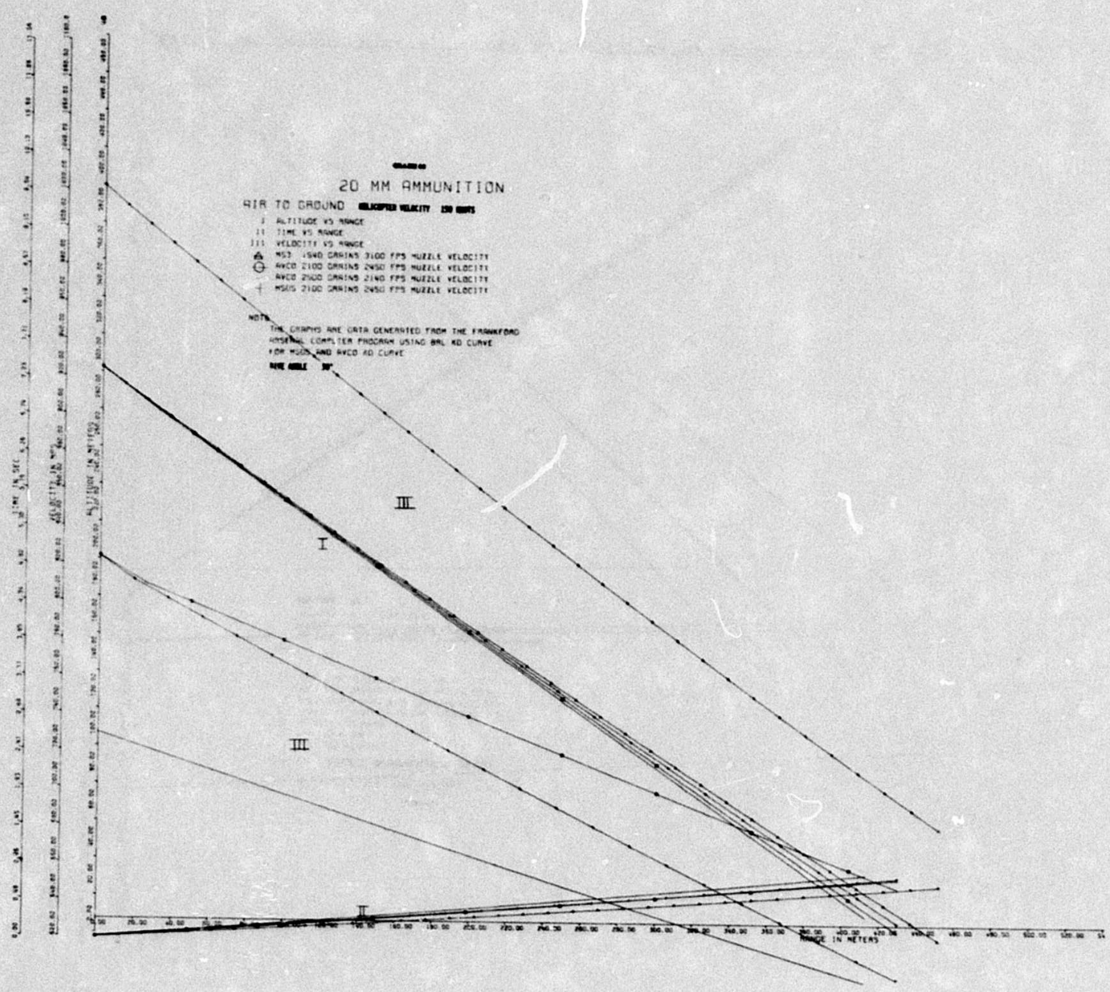


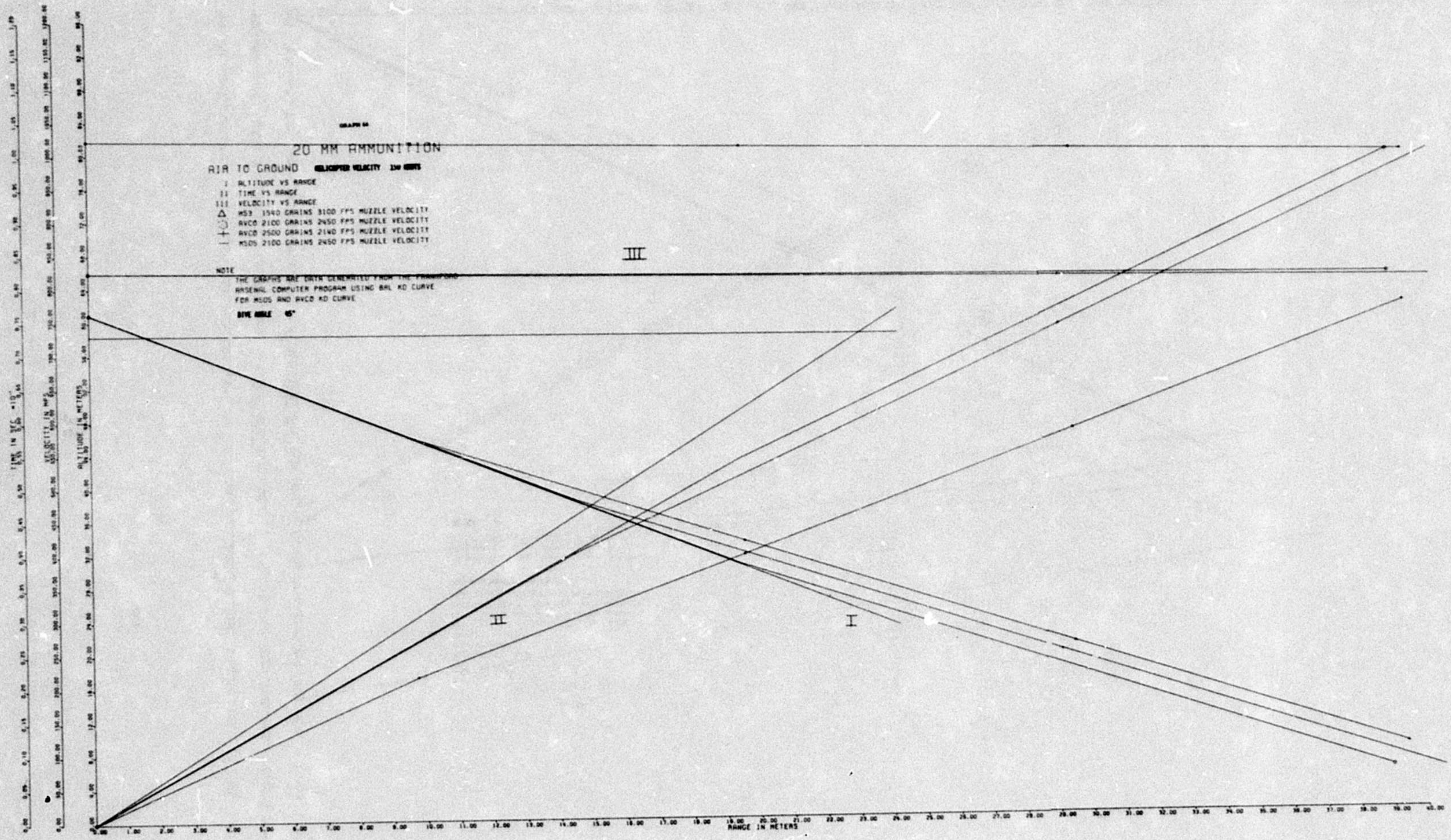
20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2102 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
MSOS 2100 GRAINS 2450 FPS MUZZLE VELOCITY
HELICOPTER VELOCITY 150 KNOTS
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR MSOS AND AVCO KD CURVE
DIVE ANGLE 15°
I
II
III
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS


20 MM AMMUNITION
AIR TO GROUND HELICOPTER VELOCITY
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M505 AND AVCO KD CURVE
DIVE ANGLE 15°
I
II
III
RANGE IN METERS
ALTITUDE IN METERS
TIME IN SEC

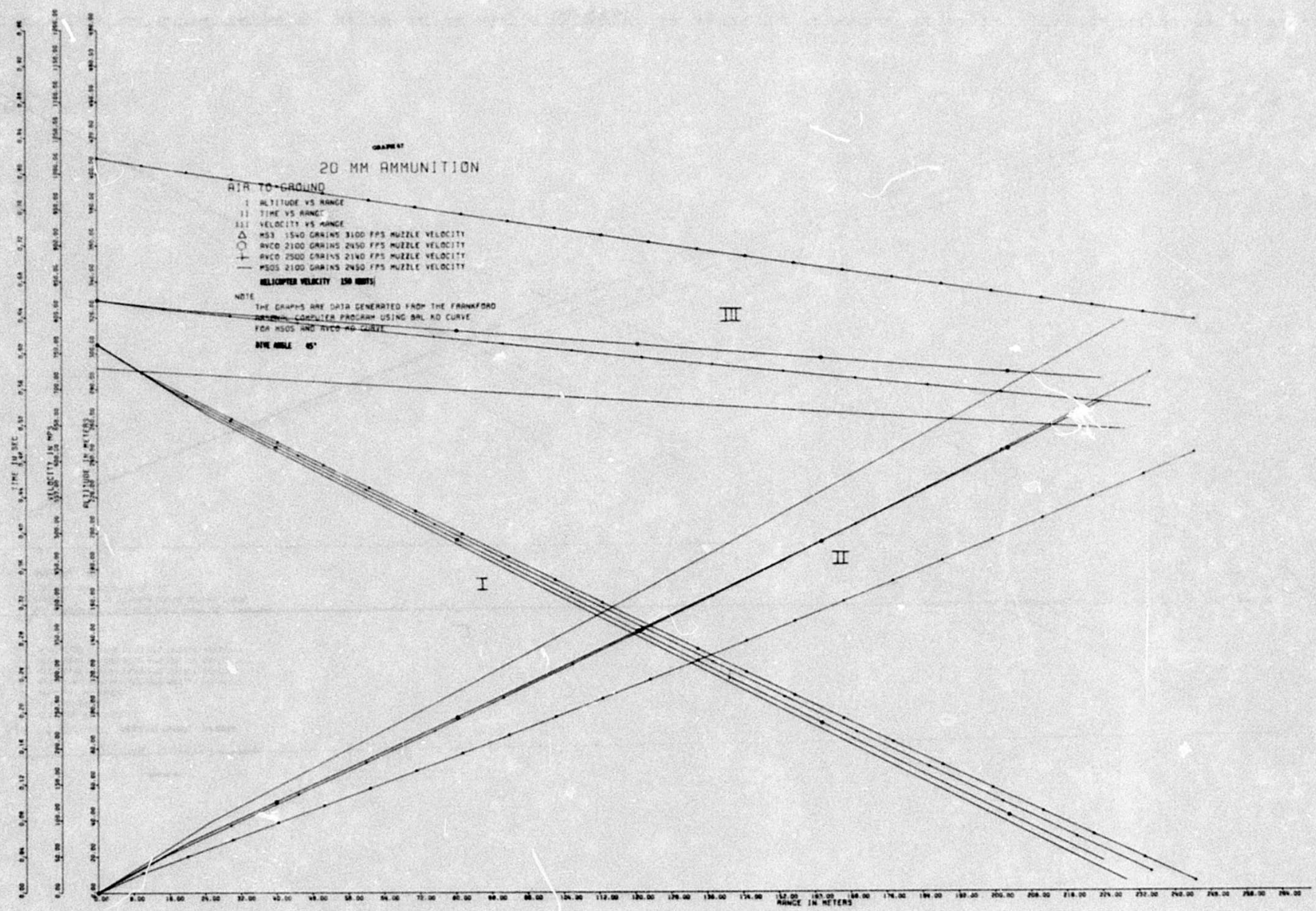


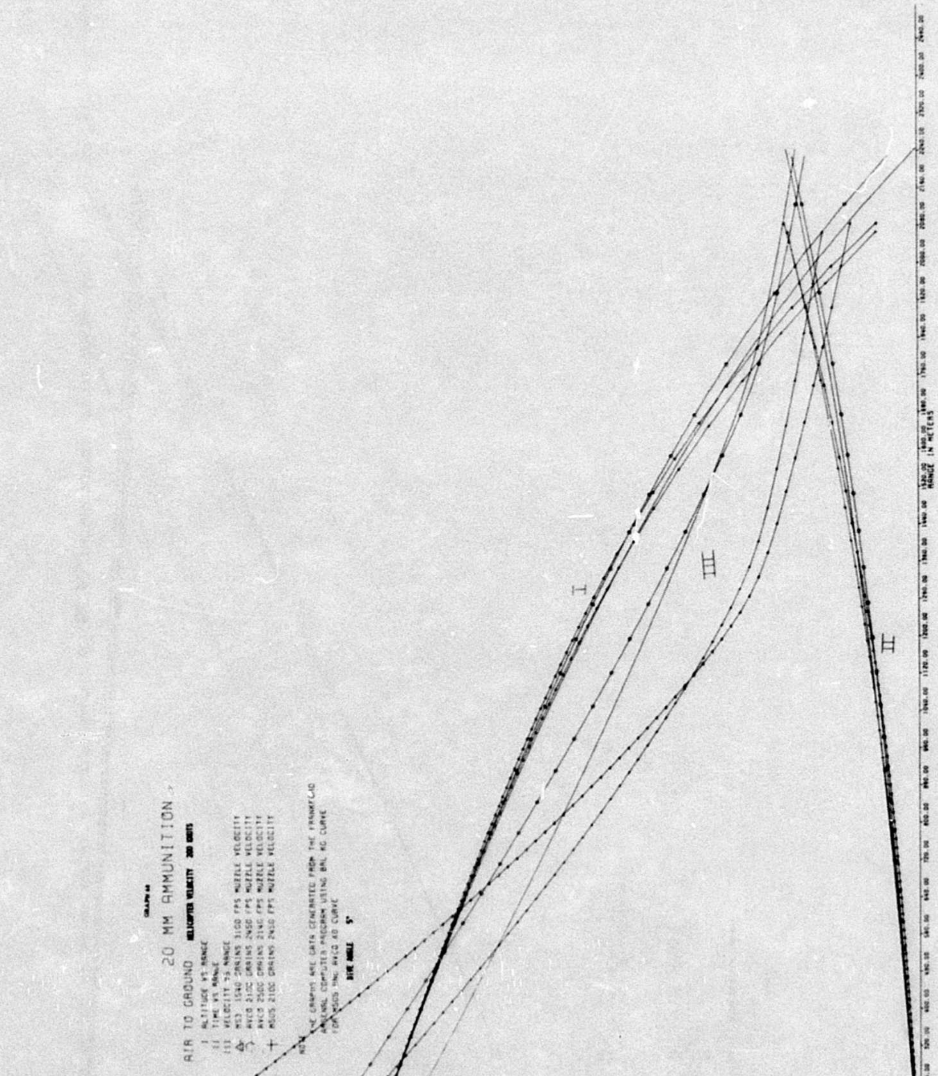
GRAPH 1
20 MM AMMUNITION
AIR TO GROUND HELICOPTER VELOCITY 150 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
MSOS 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING
FOR MSOS AND AVCO KD CURVE
DIVE ANGLE 30°
I
II
III
RANGE IN METERS


20 MM AMMUNITION
AIR TO GROUND HELICOPTER VELOCITY 150 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M505 AND AVCO KD CURVE
DIVE ANGLE 30°
I
II
III
III
RANGE IN METERS
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC

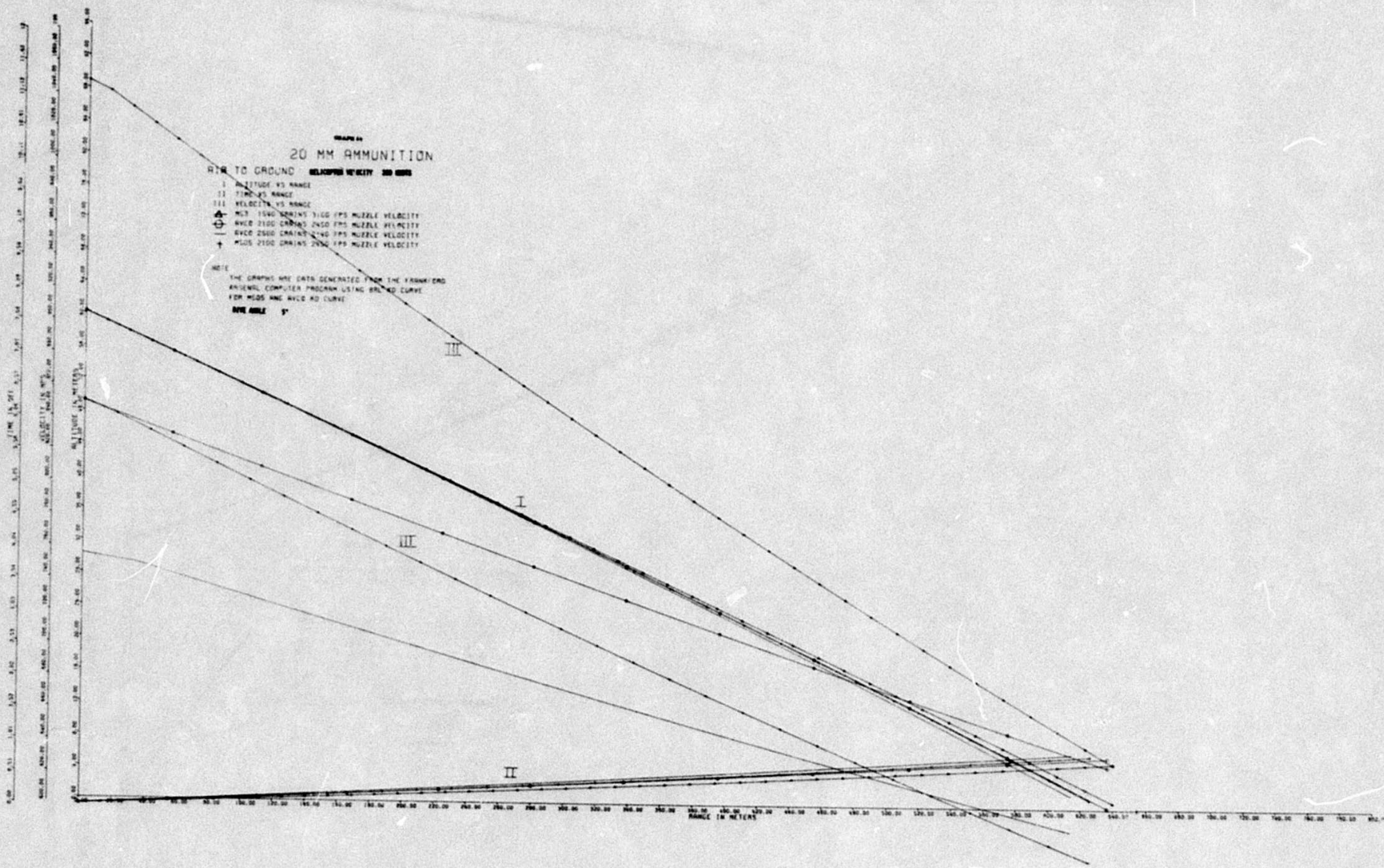


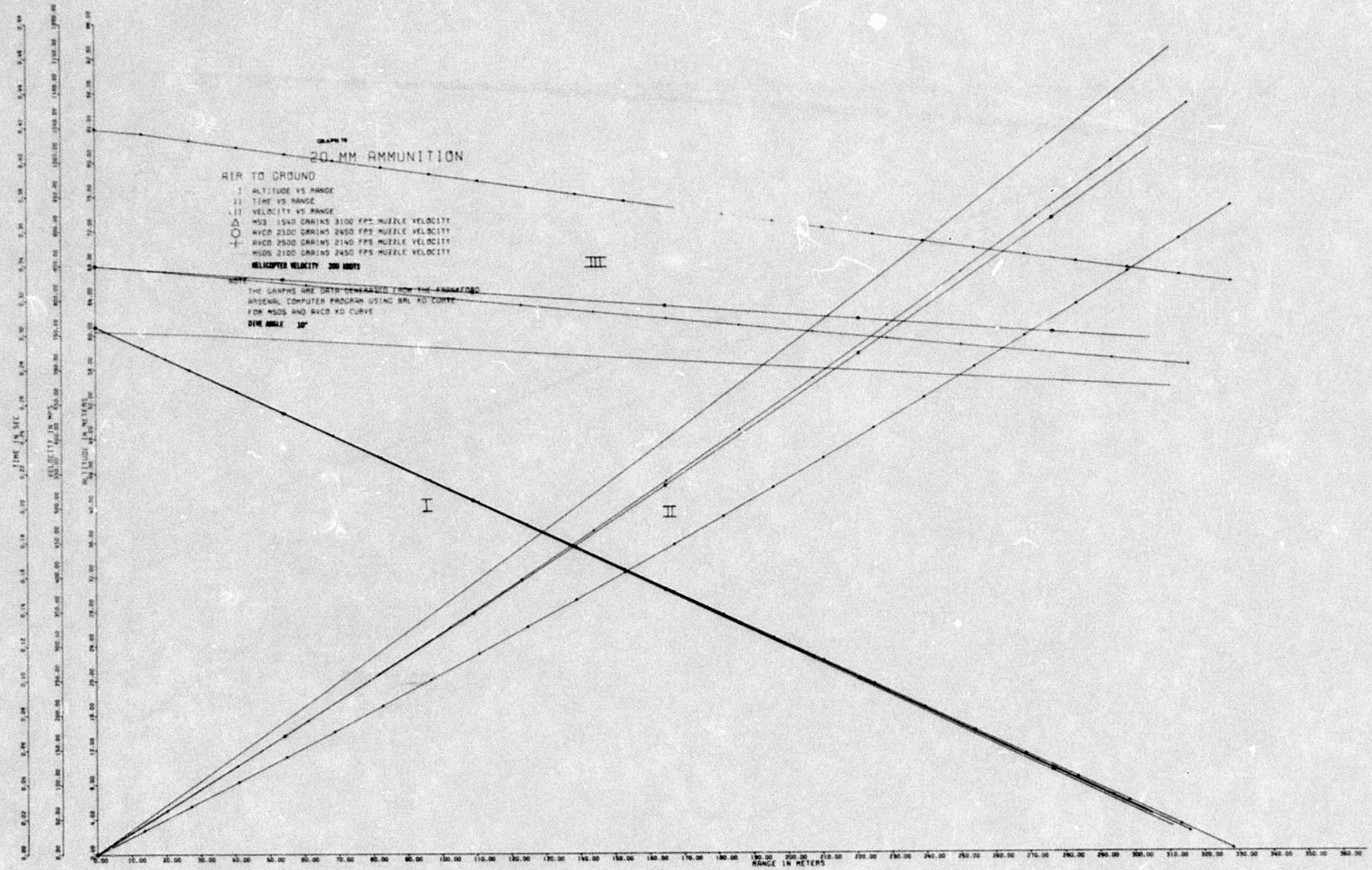
20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M505 AND AVCO KD CURVE
I
II
III
RANGE IN METERS
ALTITUDE IN METERS

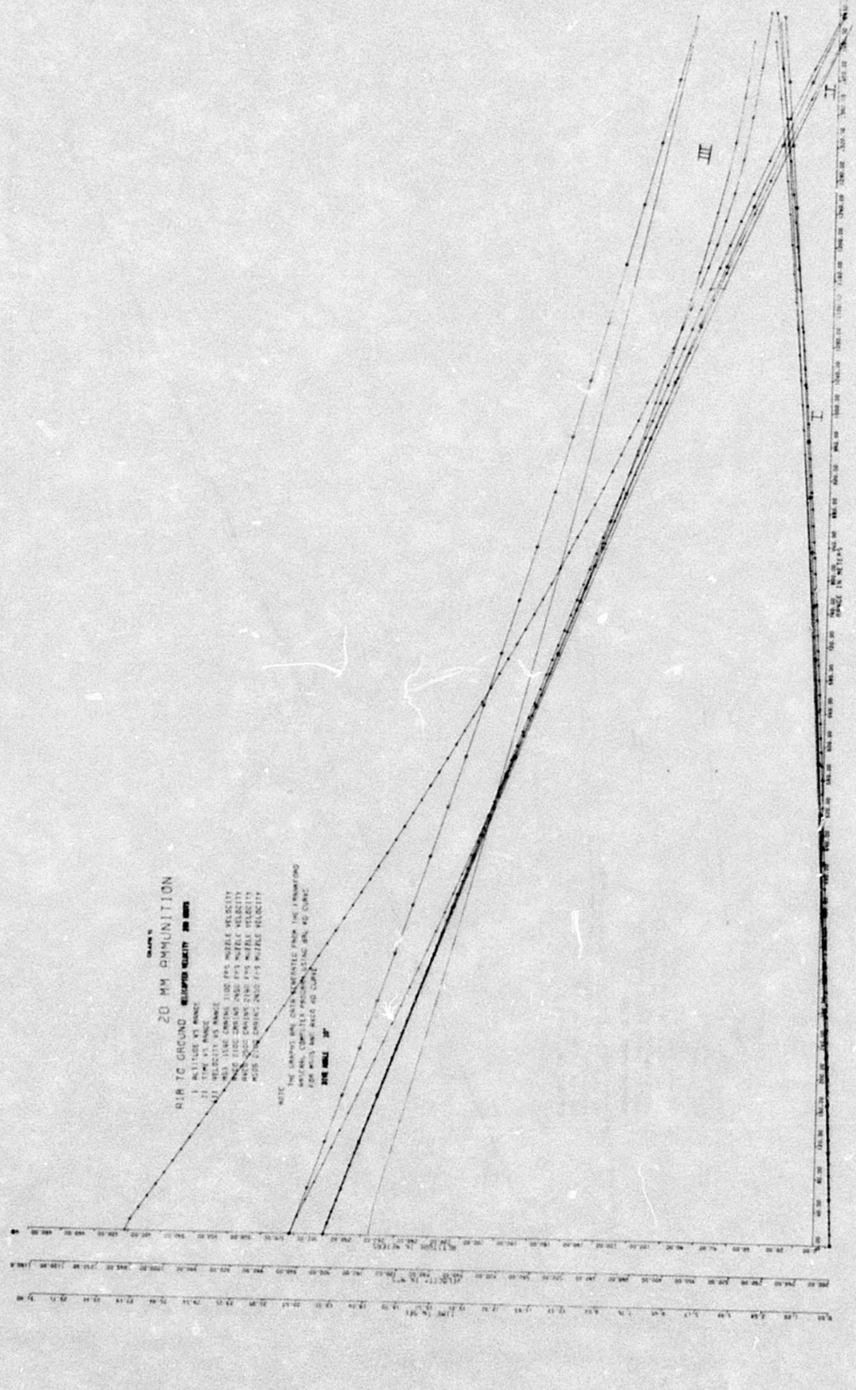

20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
HELICOPTER VELOCITY 150 KNOTS
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BAL KD CURVE
FOR M505 AND AVCO KD CURVE
DIVE ANGLE 45°
I
II
III
RANGE IN METERS
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS

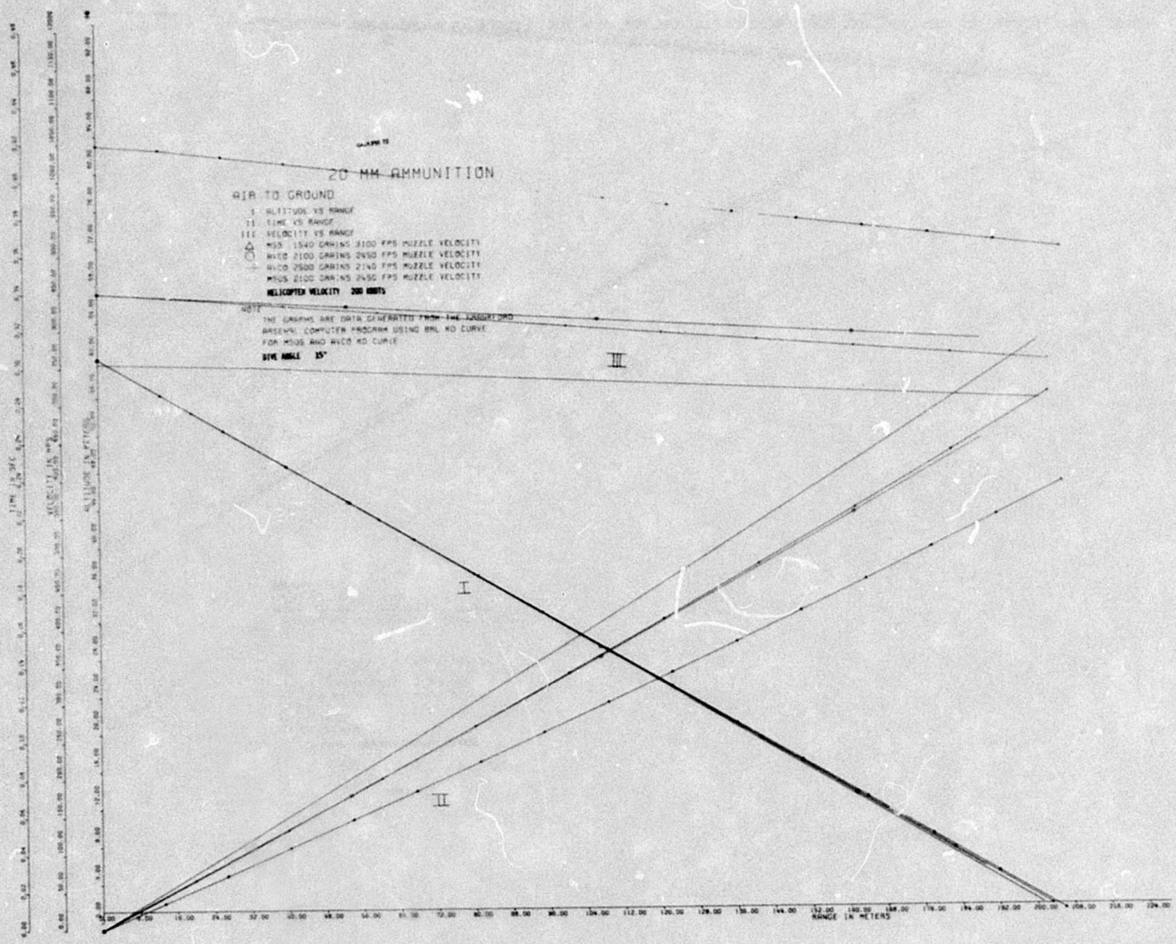


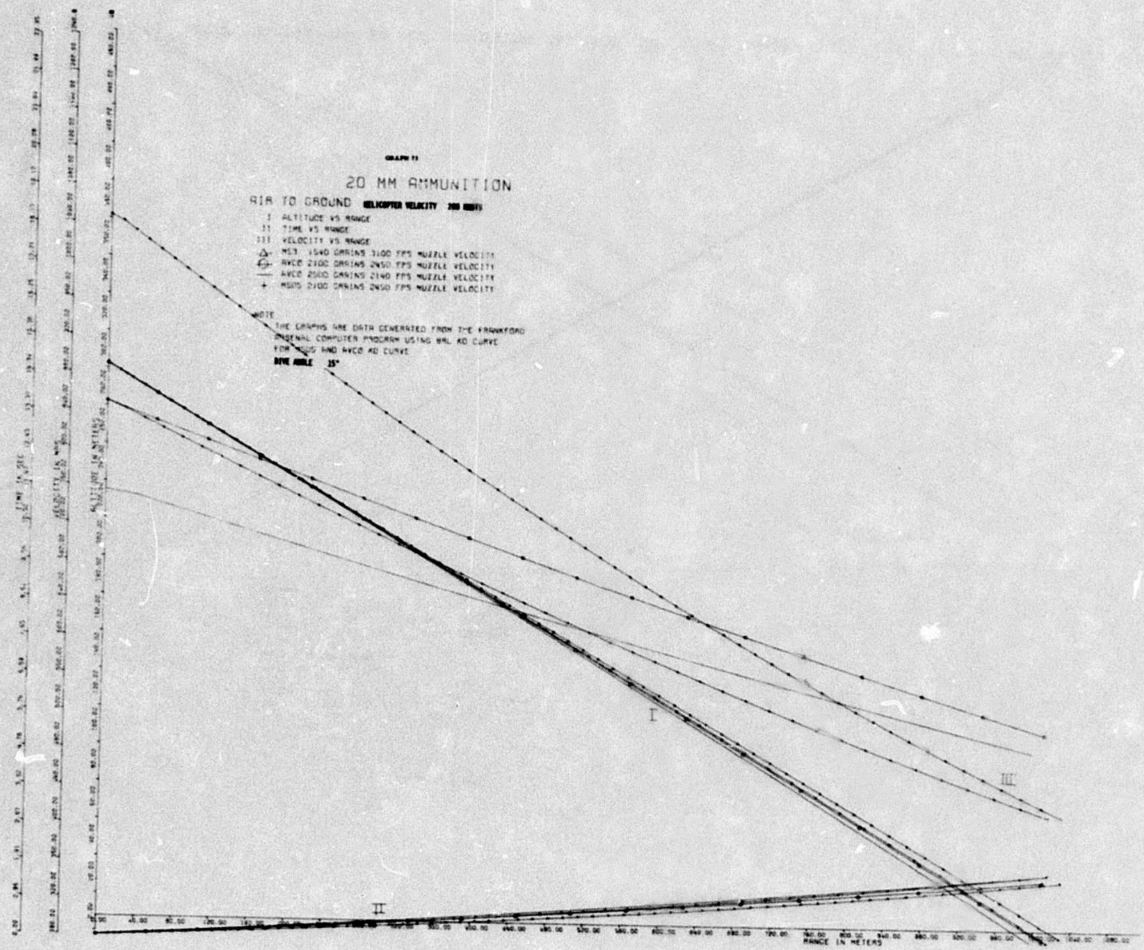
20 MM AMMUNITION
AIR TO GROUND HELICOPTER VELOCITY 200 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M505 AND AVCO KD CURVE
DIVE ANGLE 5°
I
II
III
RANGE IN METERS
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC

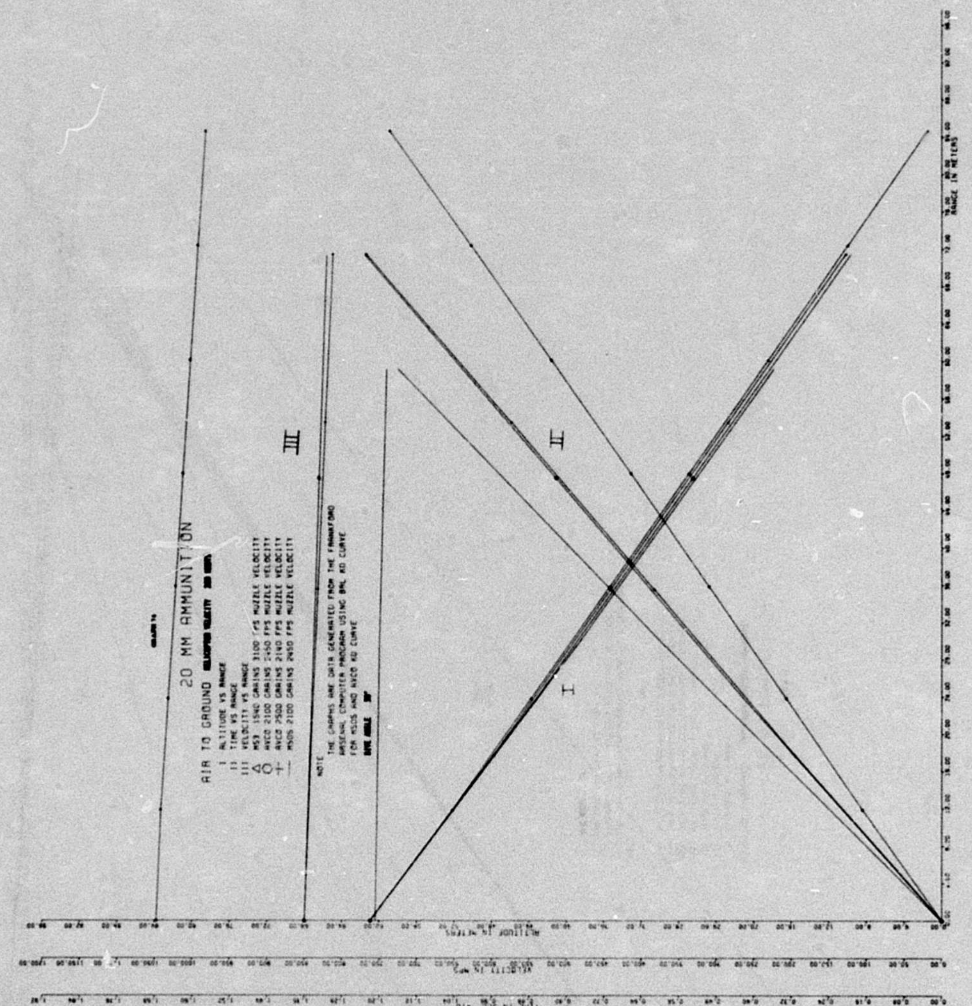

20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
MUZZLE VELOCITY
MUZZLE VELOCITY
MUZZLE VELOCITY
MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING
RANGE IN METERS
I
II
III
III

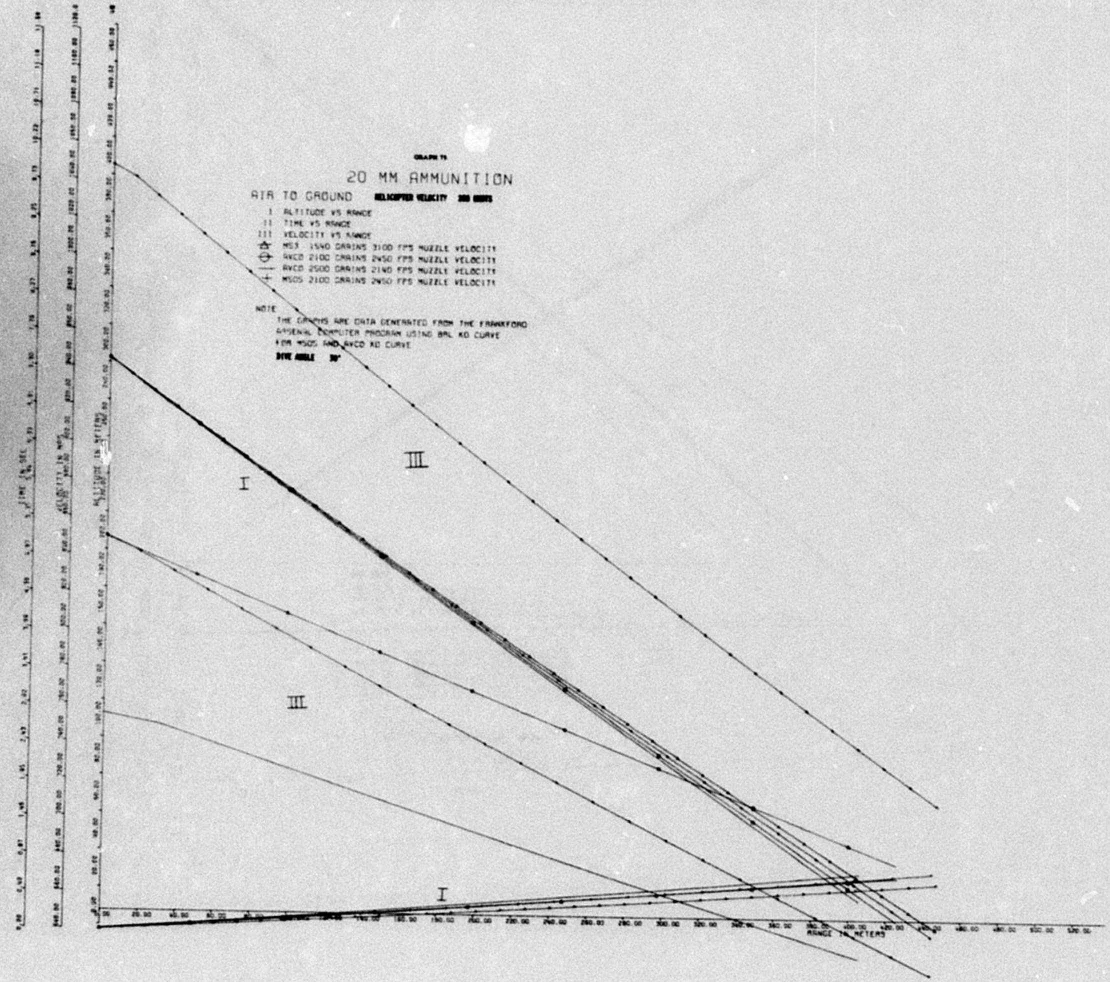

GRAPH 79
20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
HELICOPTER VELOCITY 200 KNOTS
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M505 AND AVCO KD CURVE
DIVE ANGLE 30°
I
II
III
RANGE IN METERS
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC

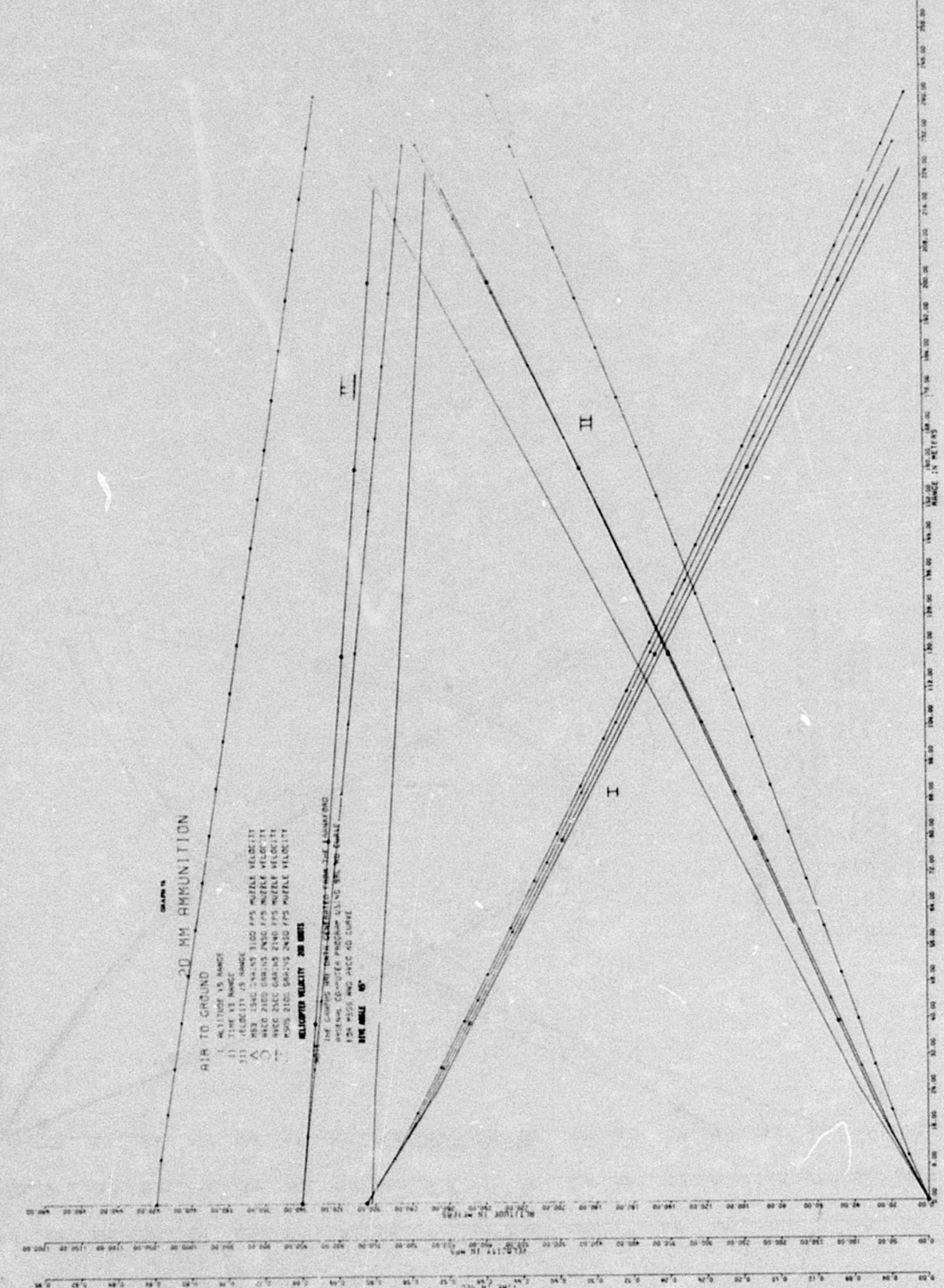

20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
NOTE
III
II
I

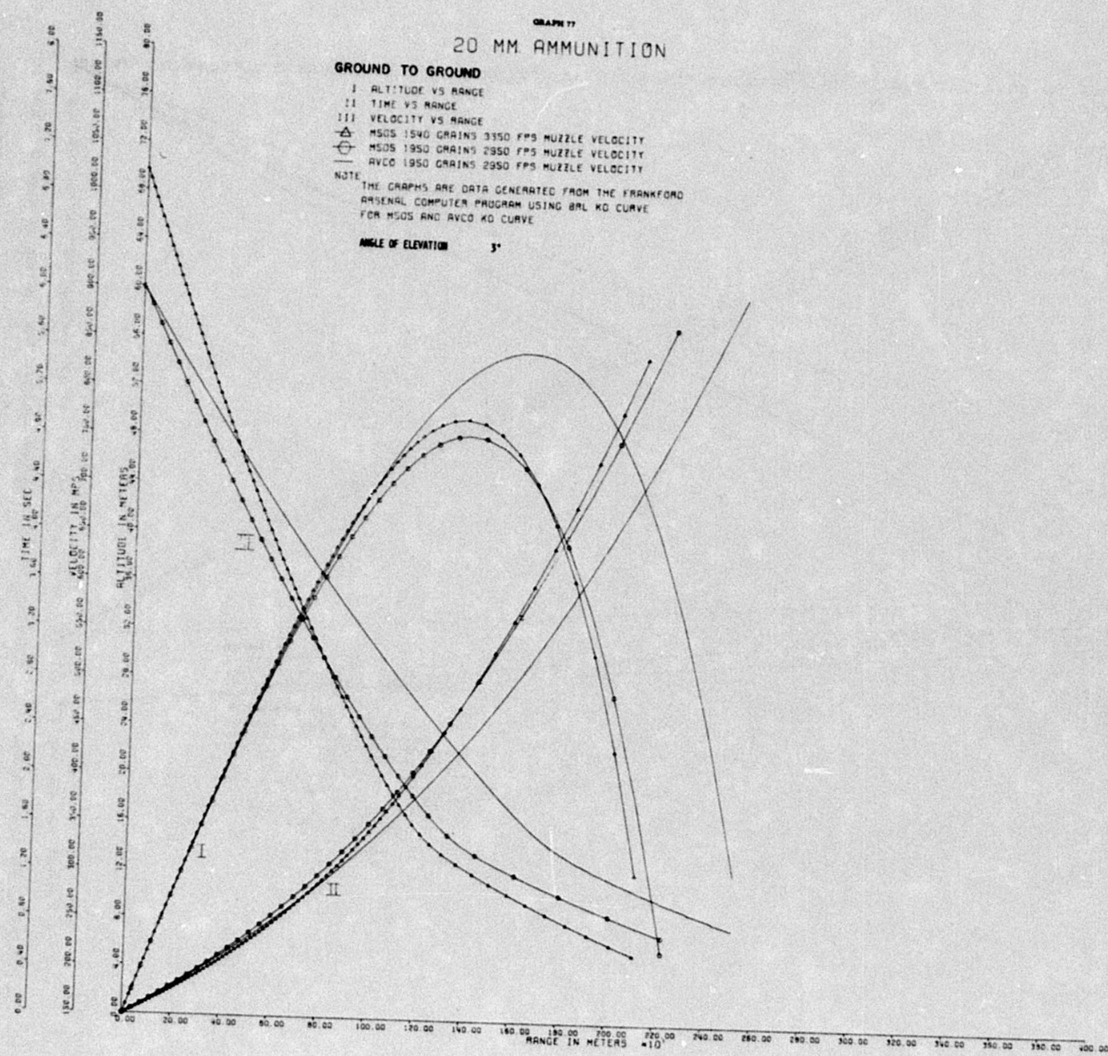

20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
HELICOPTER VELOCITY 200 KNOTS
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M505 AND AVCO KD CURVE
DIVE ANGLE 15°
I
II
III
RANGE IN METERS

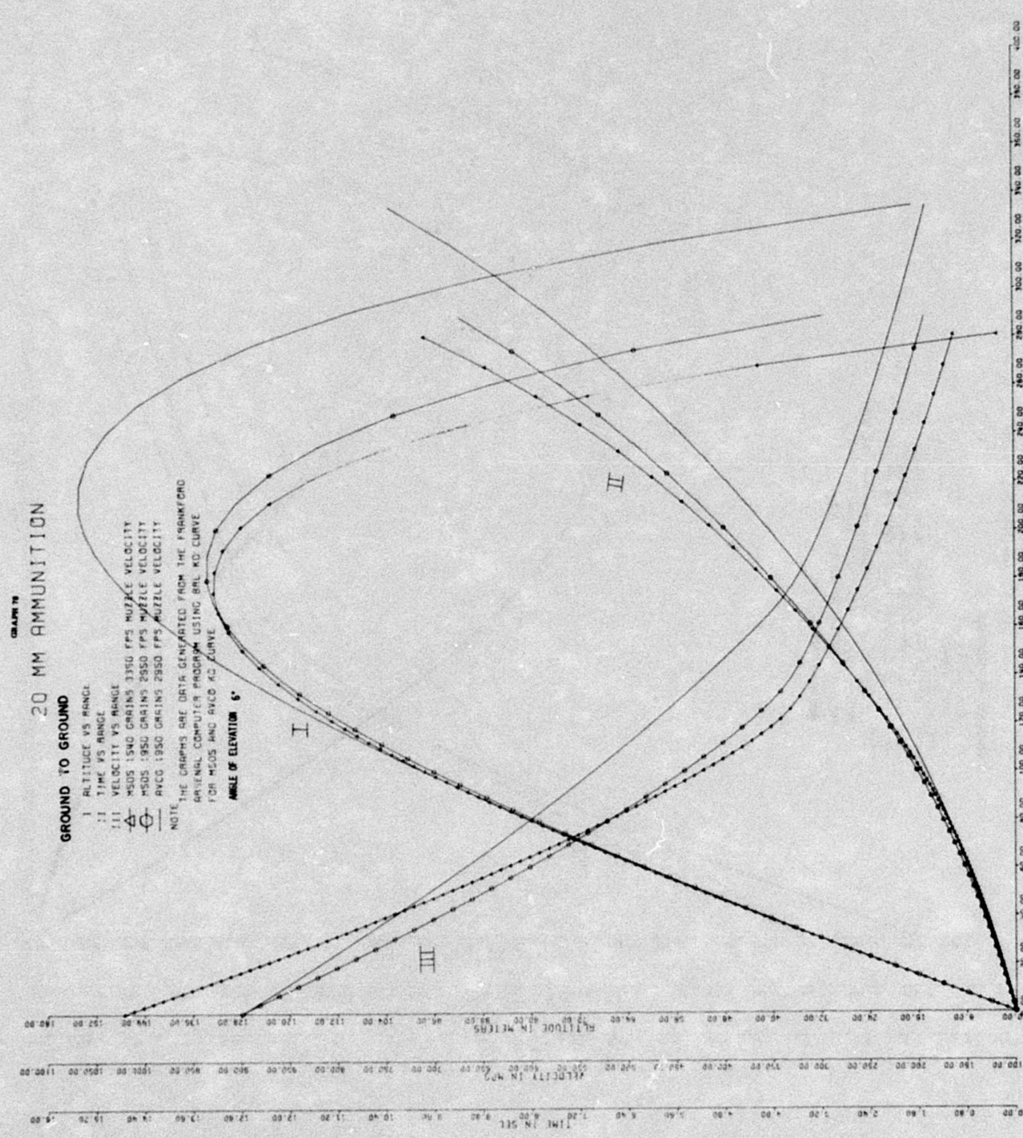

20 MM AMMUNITION
AIR TO GROUND HELICOPTER VELOCITY
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M505 AND AVCO KD CURVE
DIVE ANGLE 35°
ALTITUDE IN METERS
TIME IN SEC
RANGE IN METERS
I
II
III

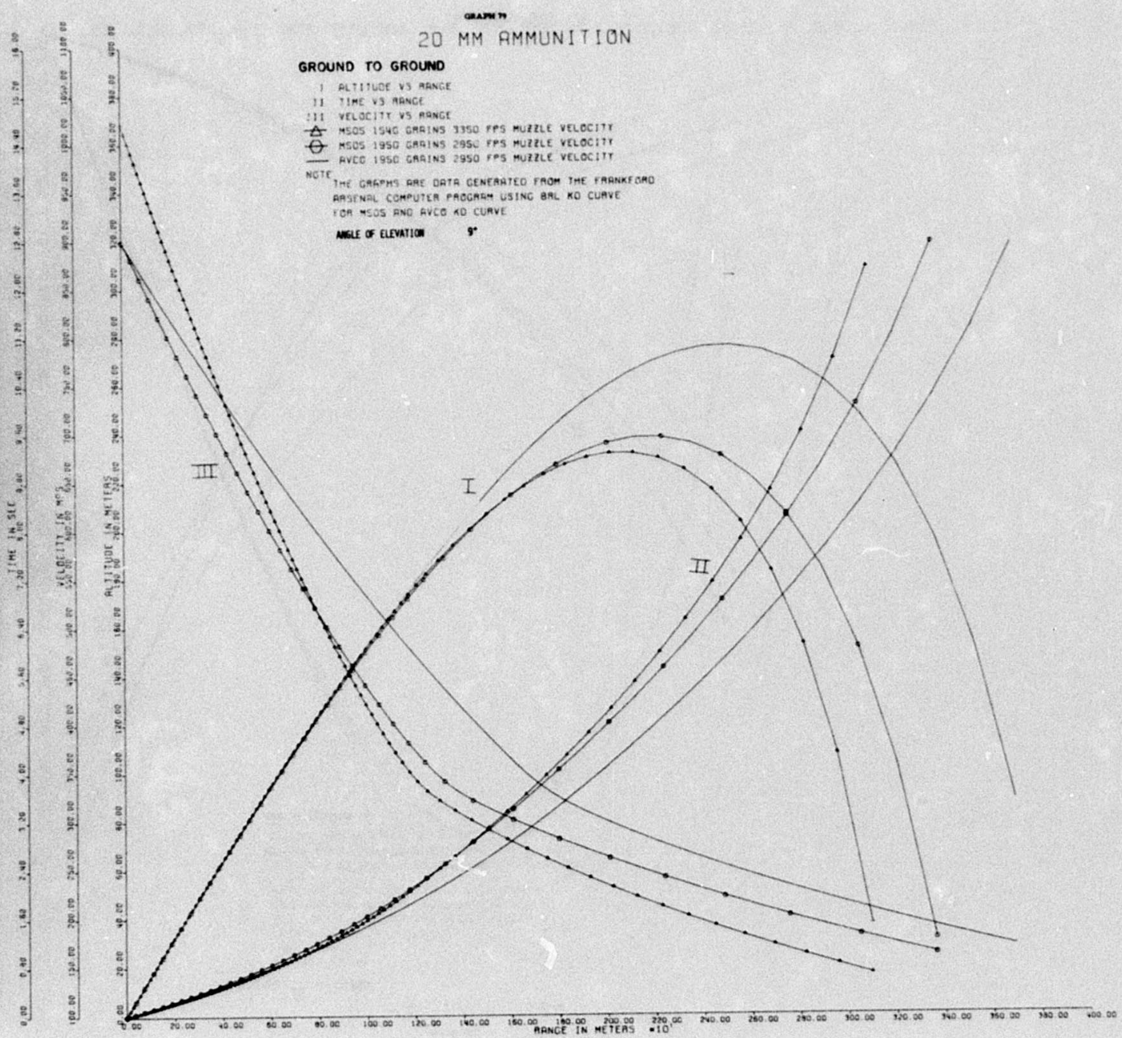

20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1590 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M505 AND AVCO KD CURVE
RANGE IN METERS
I
II
III

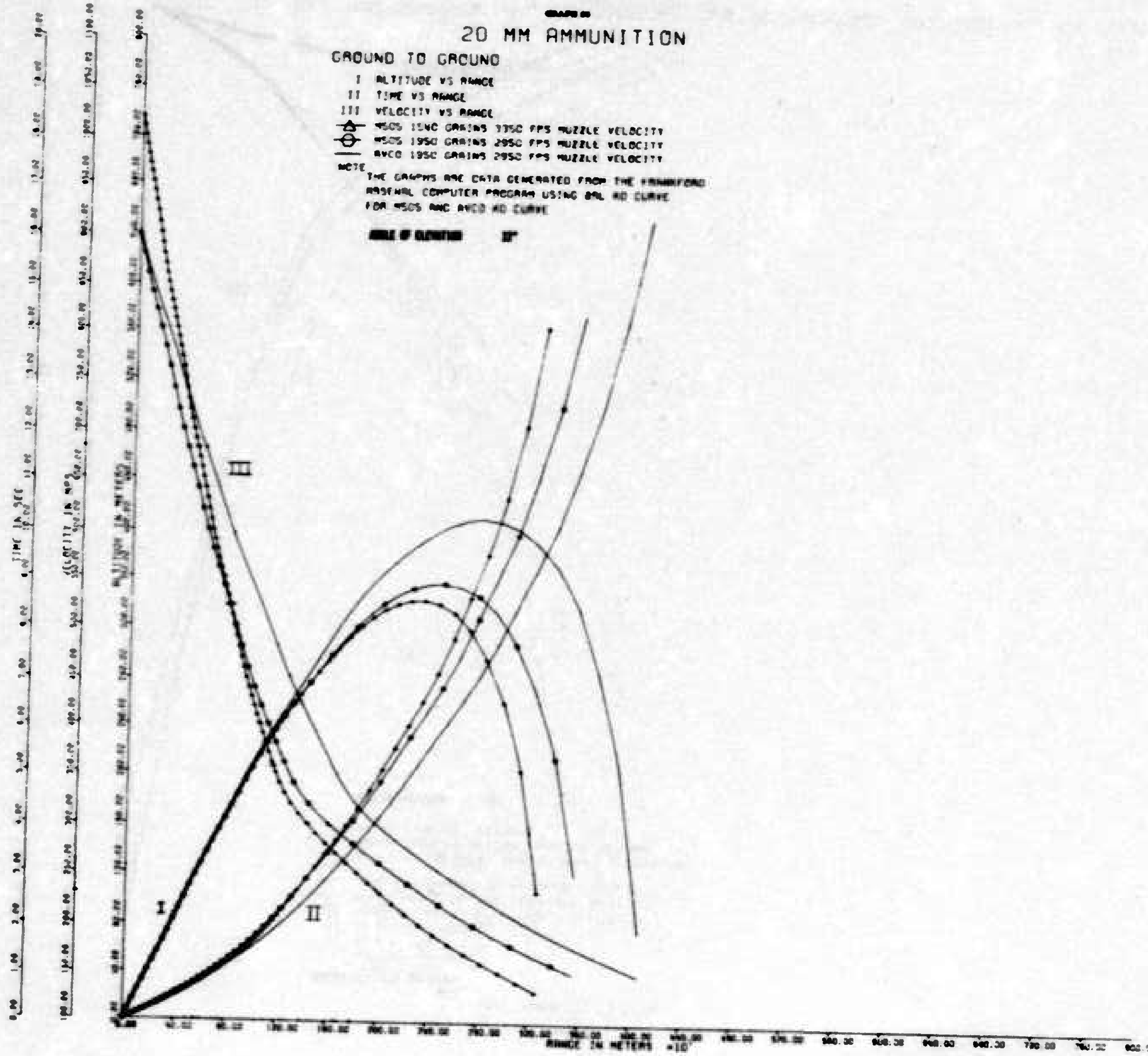

20 MM AMMUNITION
AIR TO GROUND HELICOPTER VELOCITY 300 KNOTS
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2450 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M505 AND AVCO KD CURVE
DIVE ANGLE 30°
I
III
III
I
RANGE IN METERS
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS

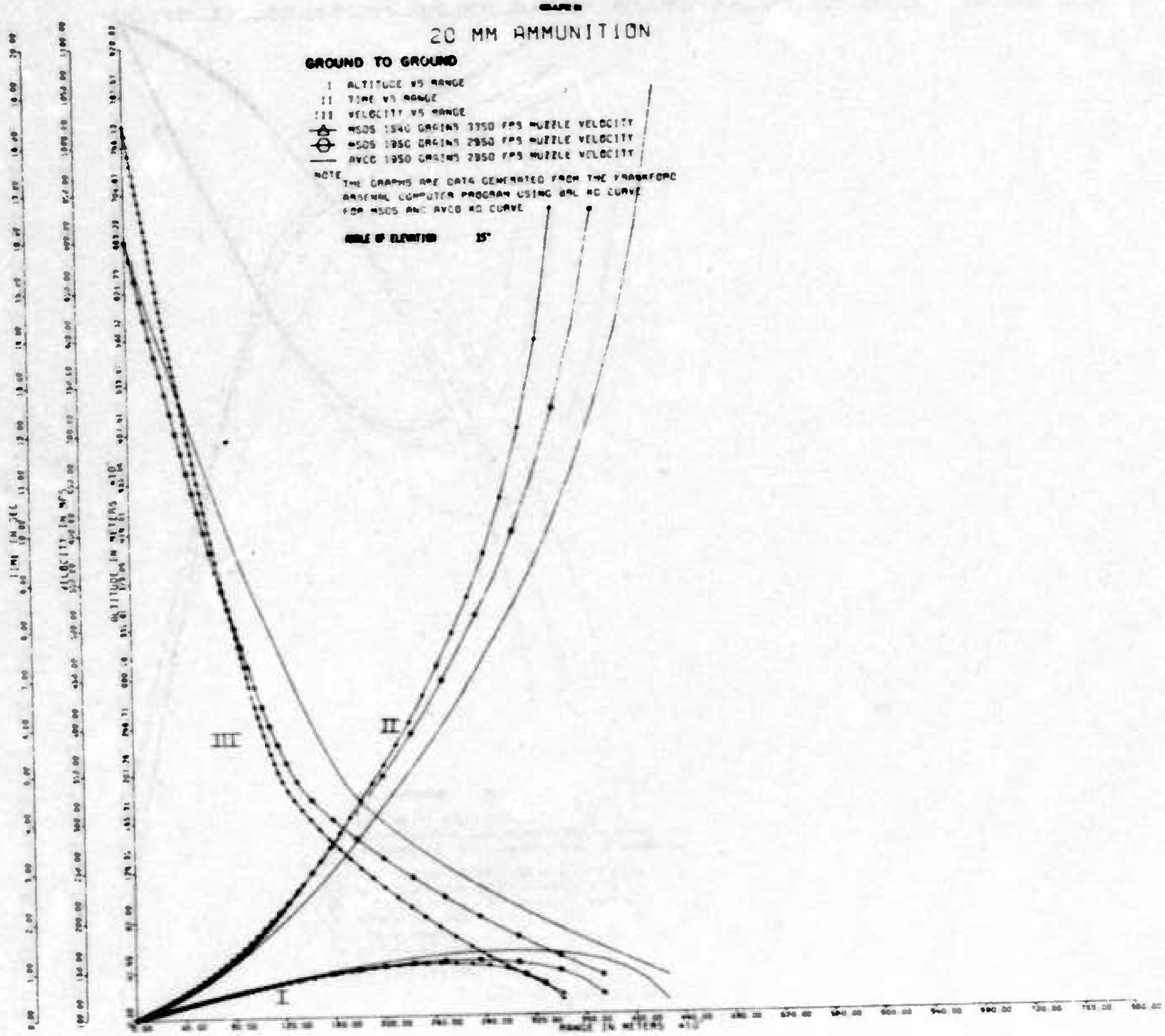

GRAPH 16
20 MM AMMUNITION
AIR TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M53 1540 GRAINS 3100 FPS MUZZLE VELOCITY
AVCO 2100 GRAINS 2450 FPS MUZZLE VELOCITY
AVCO 2500 GRAINS 2140 FPS MUZZLE VELOCITY
M505 2100 GRAINS 2430 FPS MUZZLE VELOCITY
HELICOPTER VELOCITY 200 KNOTS
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M505 AND AVCO KD CURVE
DIVE ANGLE 45°
I
II
III
RANGE IN METERS

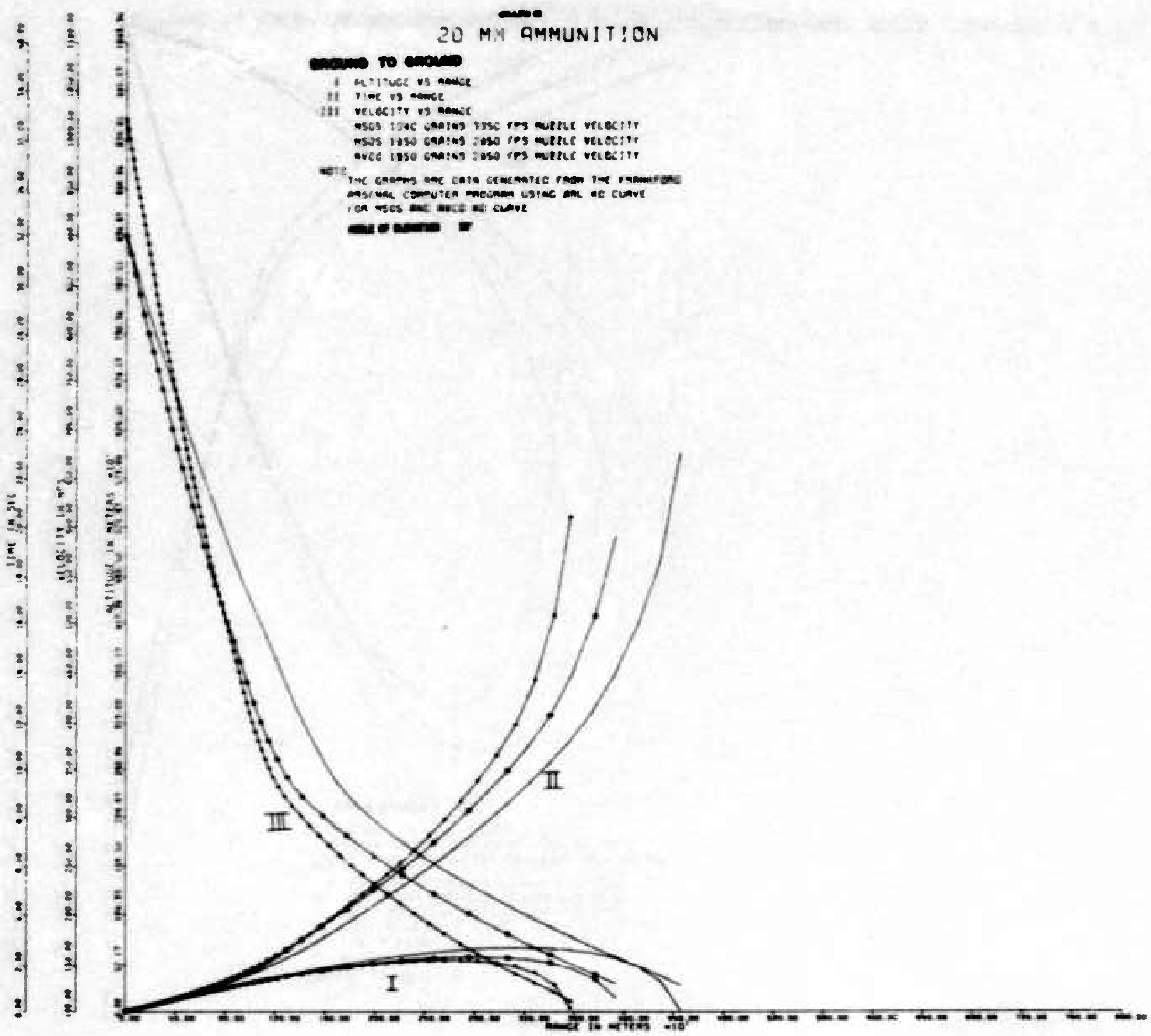

GRAPH 77
20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
MSDS 1540 GRAINS 3350 FPS MUZZLE VELOCITY
MSDS 1950 GRAINS 2950 FPS MUZZLE VELOCITY
AVCO 1950 GRAINS 2950 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR MSDS AND AVCO KD CURVE
ANGLE OF ELEVATION 3°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS *10

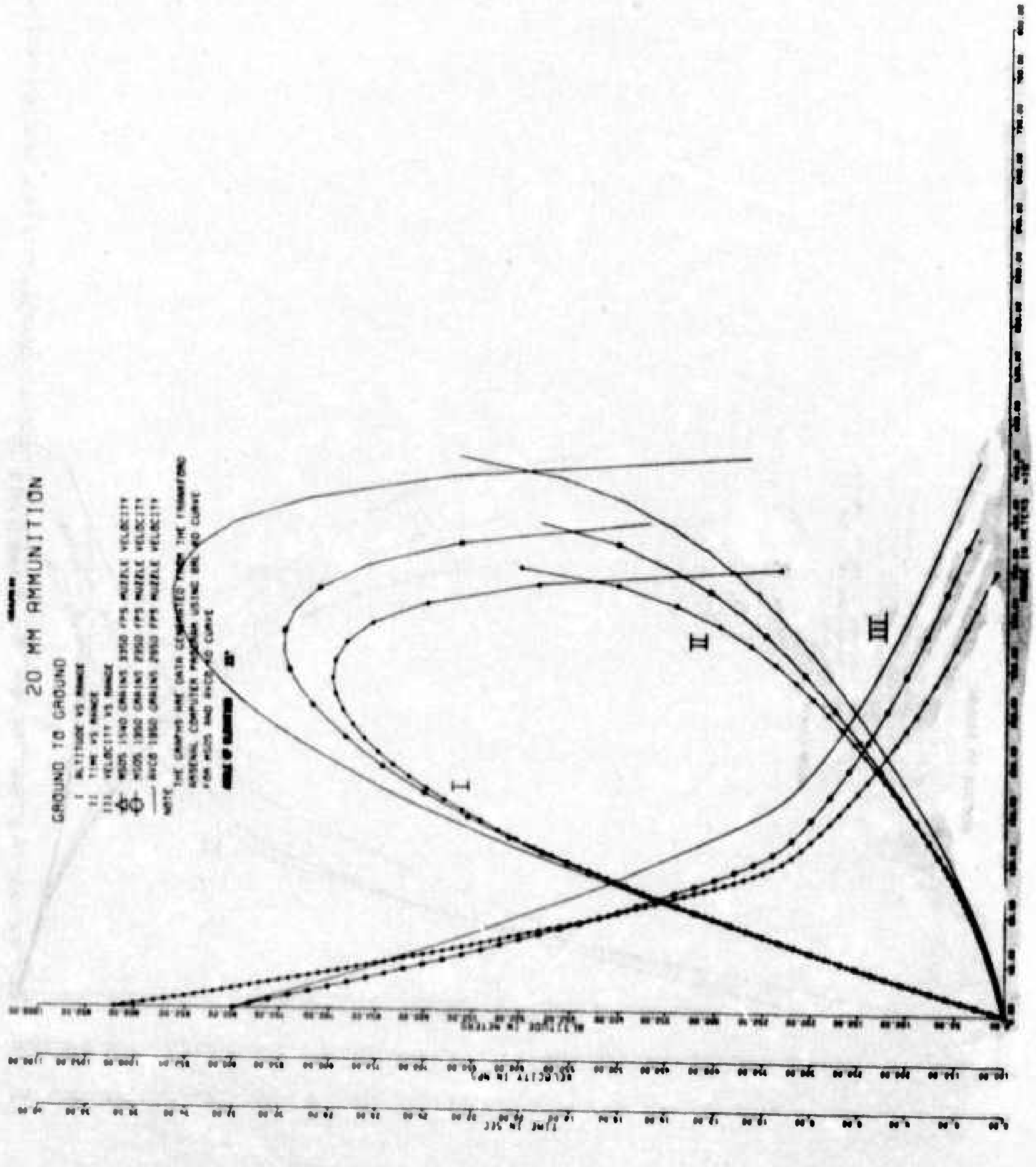

20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M505 1540 GRAINS 3350 FPS MUZZLE VELOCITY
M505 1950 GRAINS 2950 FPS MUZZLE VELOCITY
AVCO 1950 GRAINS 2950 FPS MUZZLE VELOCITY
NOTE THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M505 AND AVCO KD CURVE
ANGLE OF ELEVATION 6°
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC
RANGE IN METERS ×10
I
II
III


GRAPH 79
20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
MSOS 1540 GRAINS 3350 FPS MUZZLE VELOCITY
MSOS 1950 GRAINS 2950 FPS MUZZLE VELOCITY
AVCO 1950 GRAINS 2950 FPS MUZZLE VELOCITY
NOTE THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR MSOS AND AVCO KD CURVE
ANGLE OF ELEVATION 9°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS *10
I
II
III

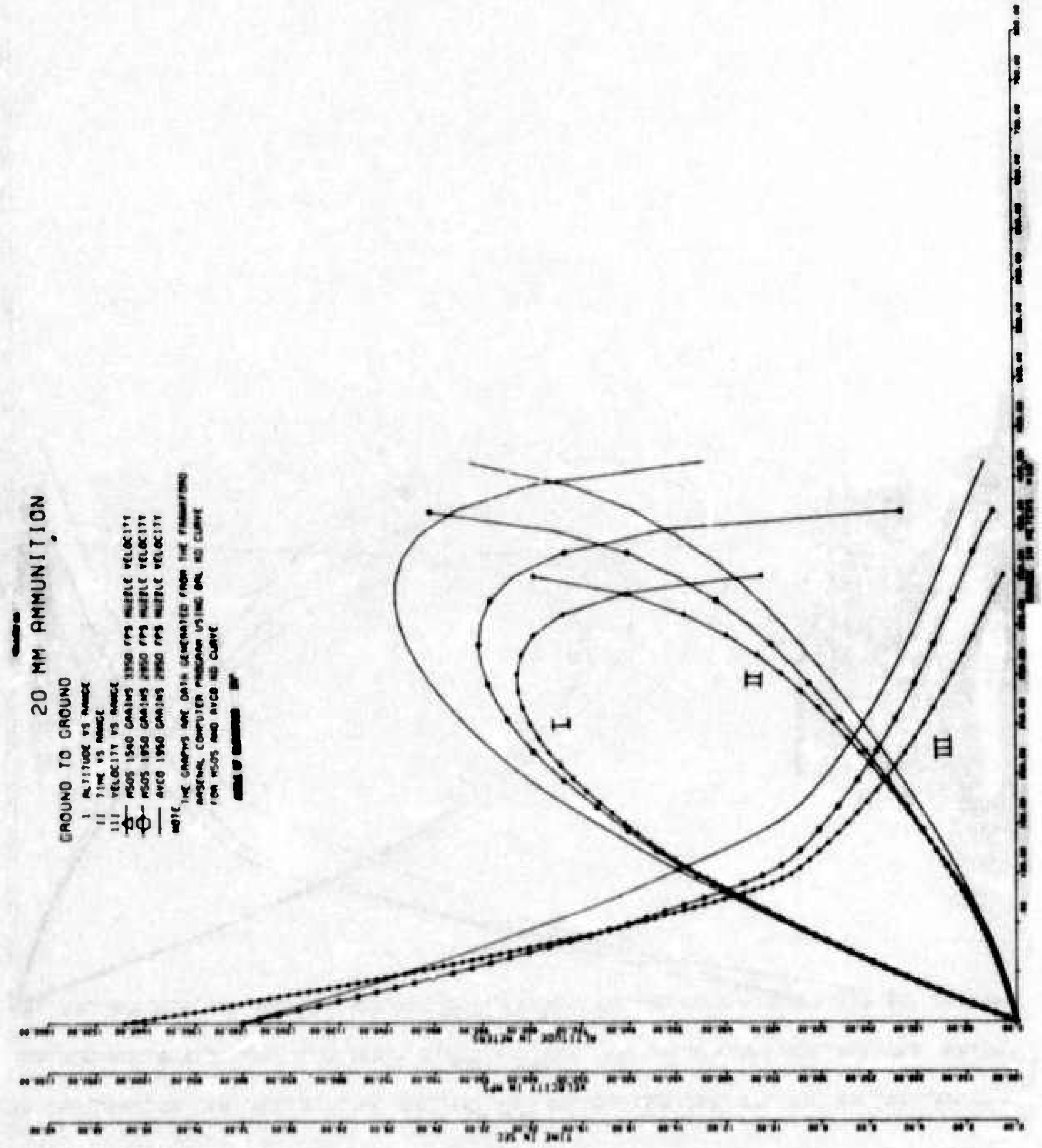

20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M505 1550 GRAINS 3350 FPS MUZZLE VELOCITY
M505 1950 GRAINS 2950 FPS MUZZLE VELOCITY
AVCO 1950 GRAINS 2950 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M505 AND AVCO KD CURVE
I
II
III
RANGE IN METERS
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS

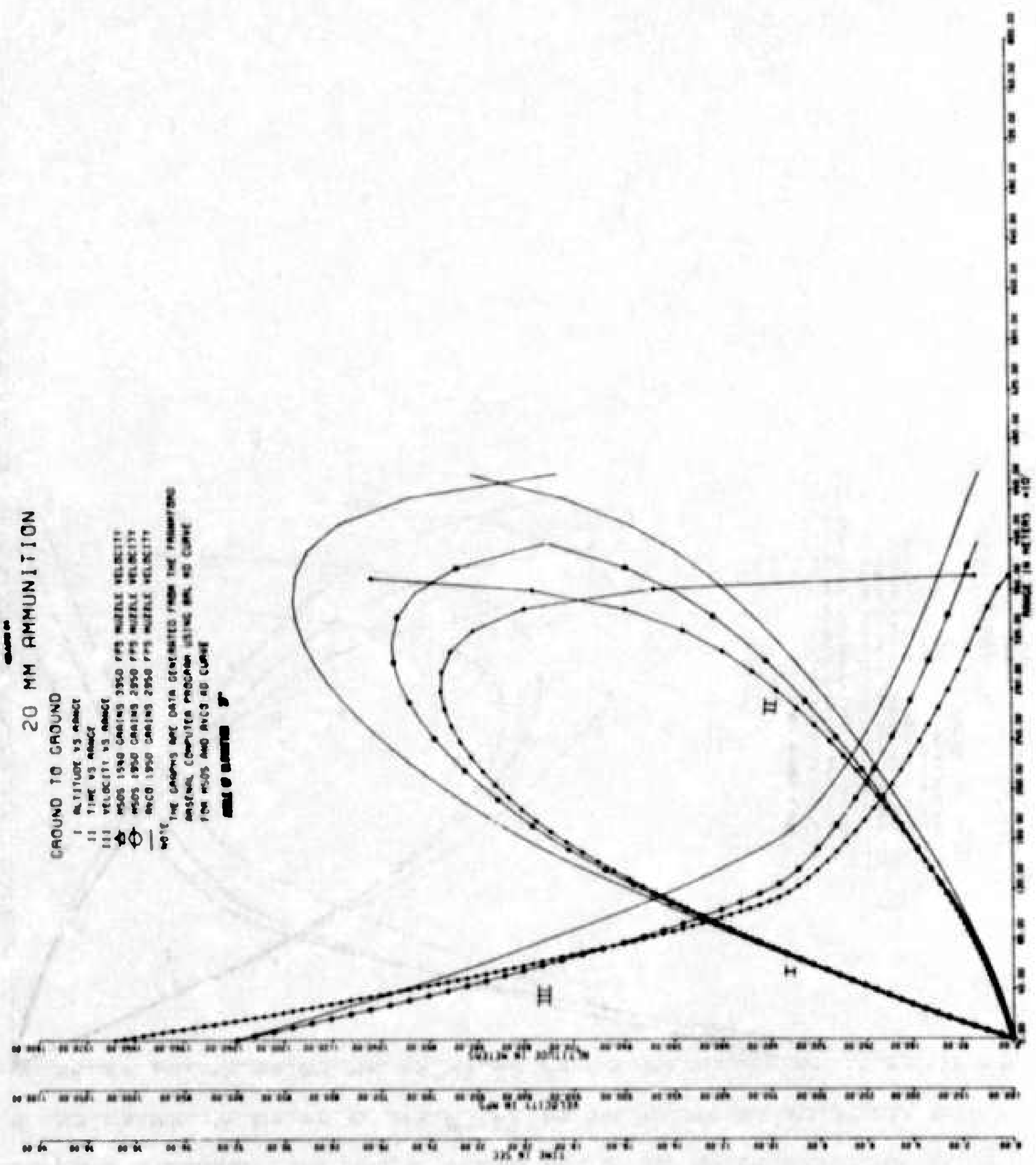

20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
NOTE
I
II
III

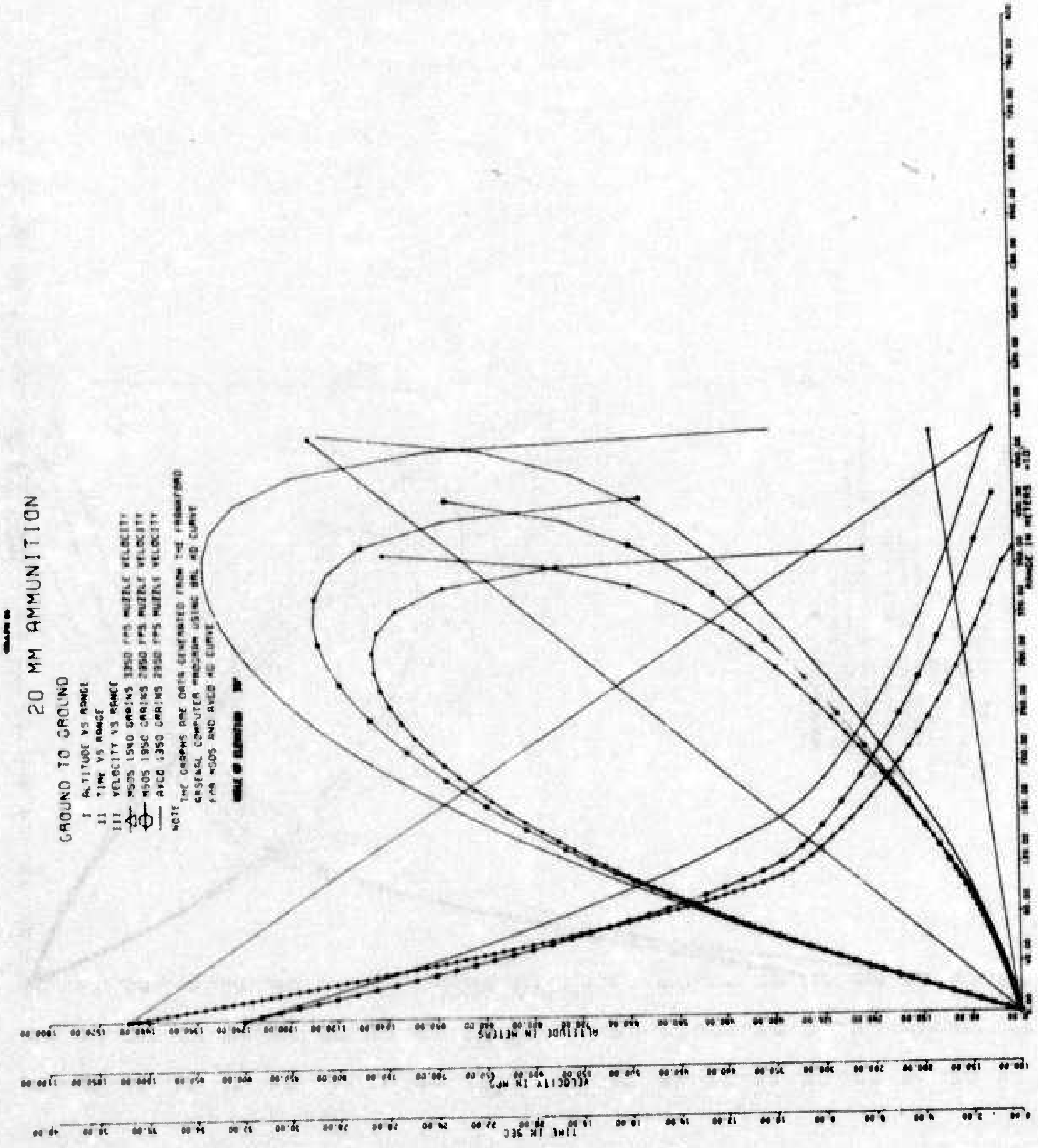

20 MM AMMUNITION
TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
RANGE IN METERS
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC
I
II
III

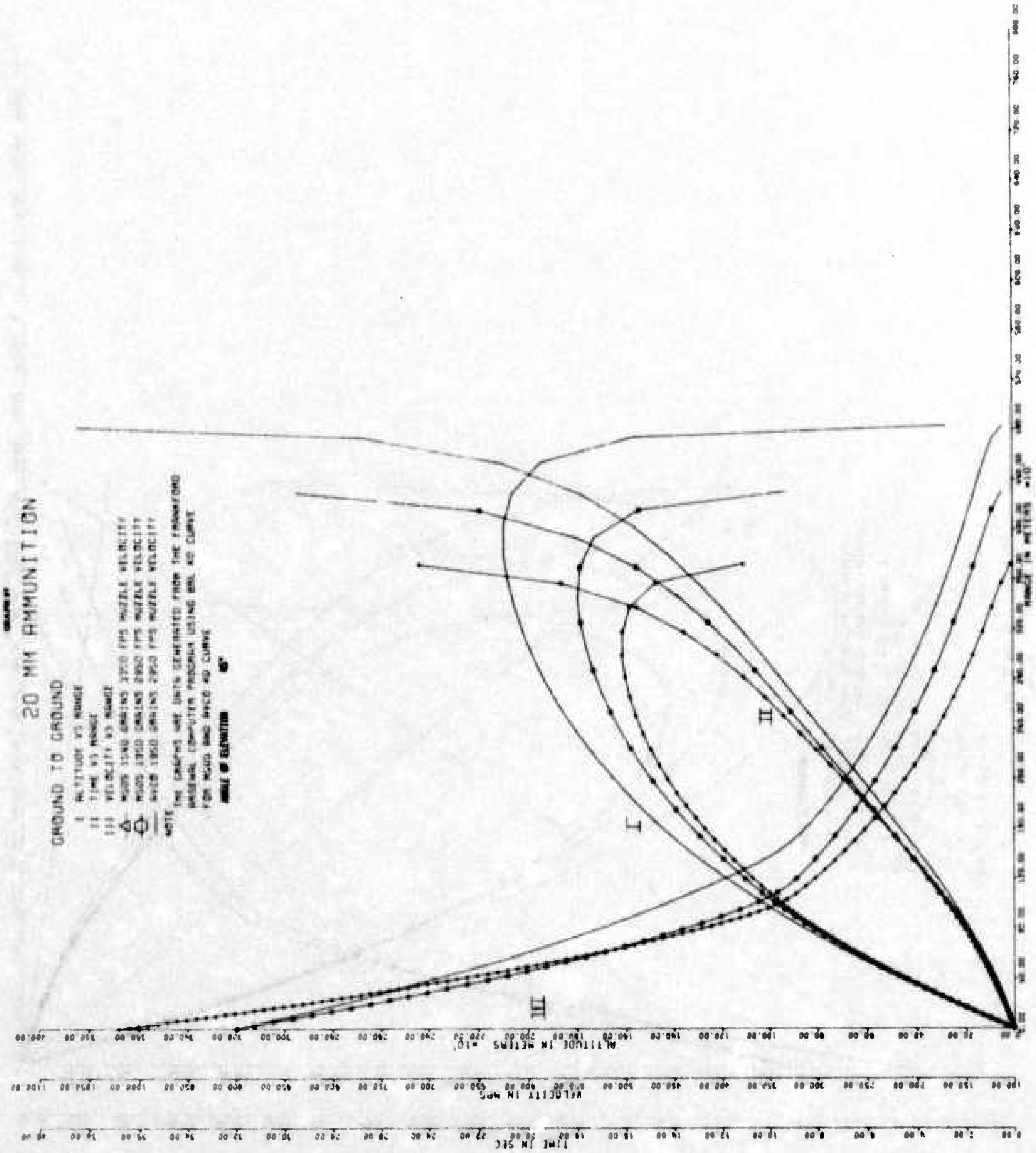


20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
NOTE
I
II
III

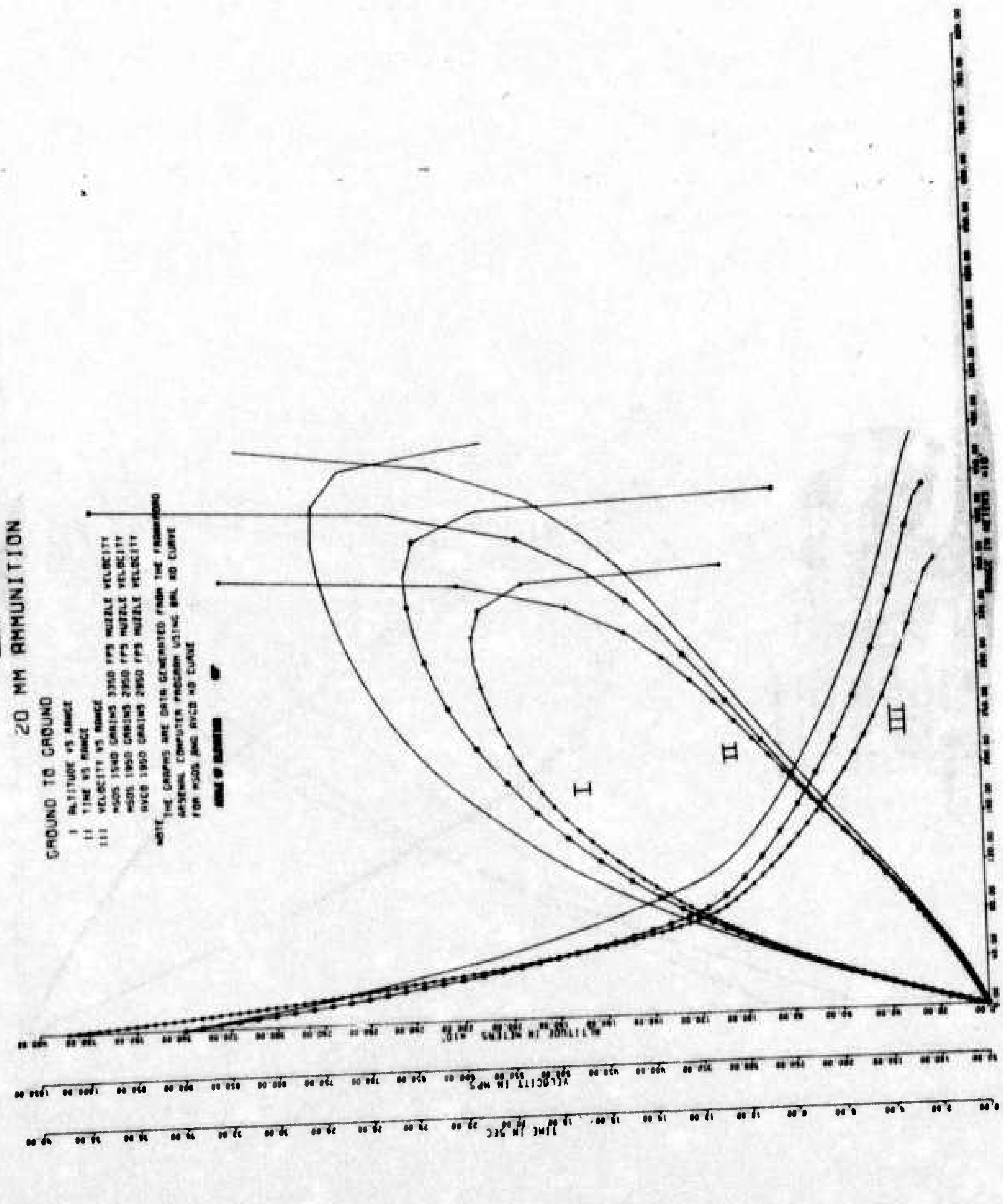

20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
I
II
III

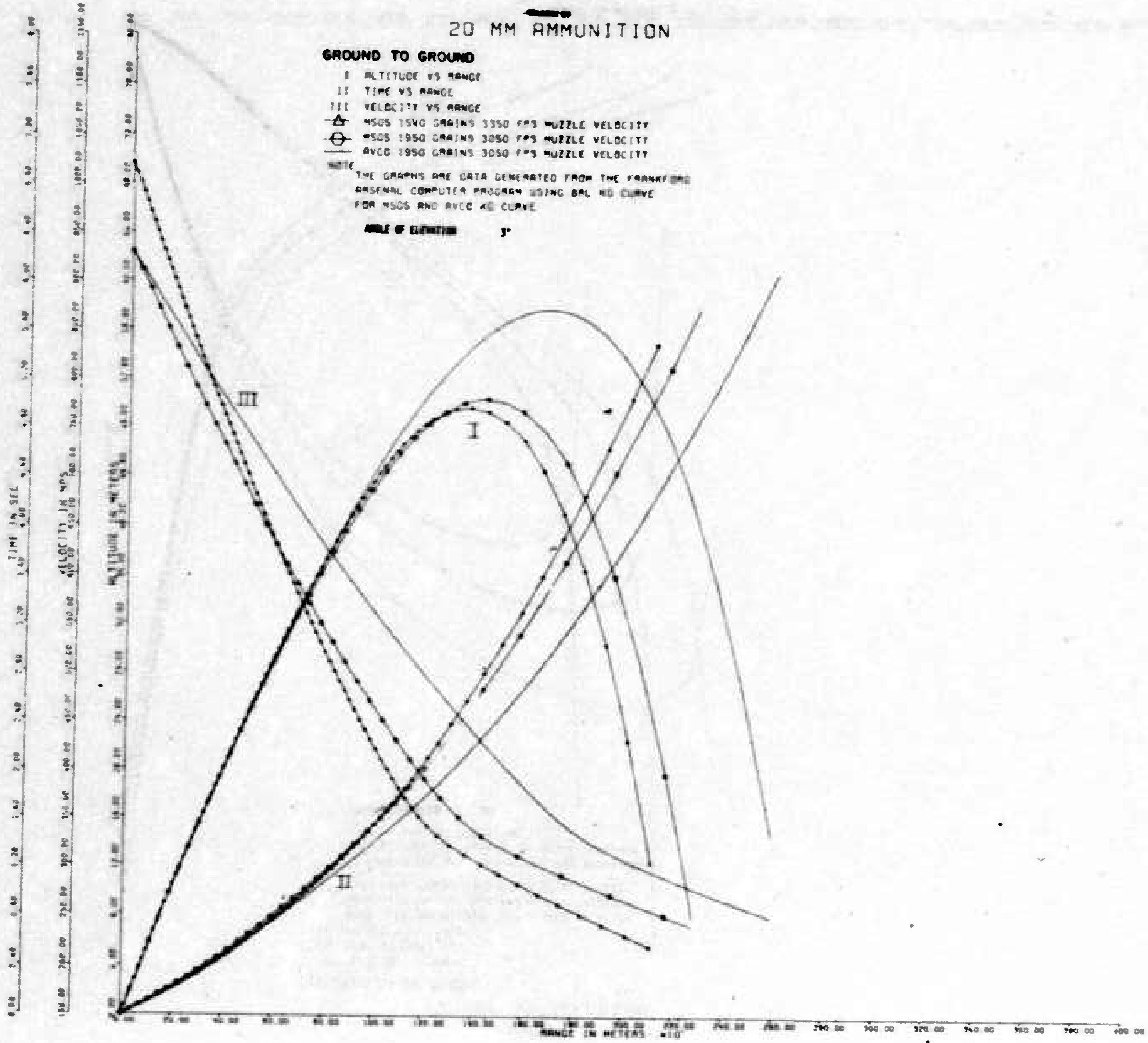

20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
I
II
III

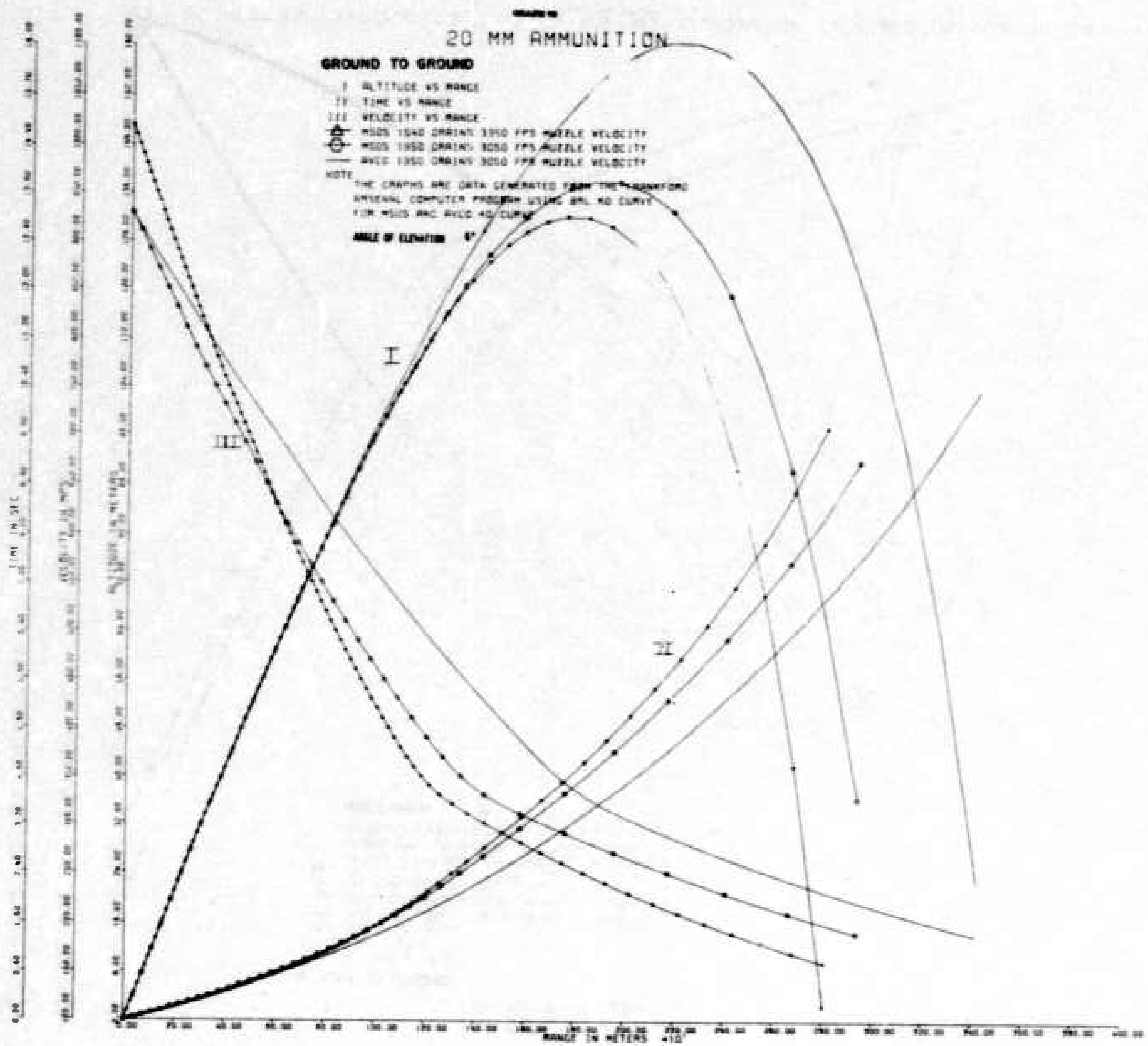

20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M505 1540 GRAINS 3350 FPS MUZZLE VELOCITY
M505 1950 GRAINS 2950 FPS MUZZLE VELOCITY
AVCO 1350 GRAINS 2950 FPS MUZZLE VELOCITY
NOTE THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M505 AND AVCO KD CURVE
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC
RANGE IN METERS

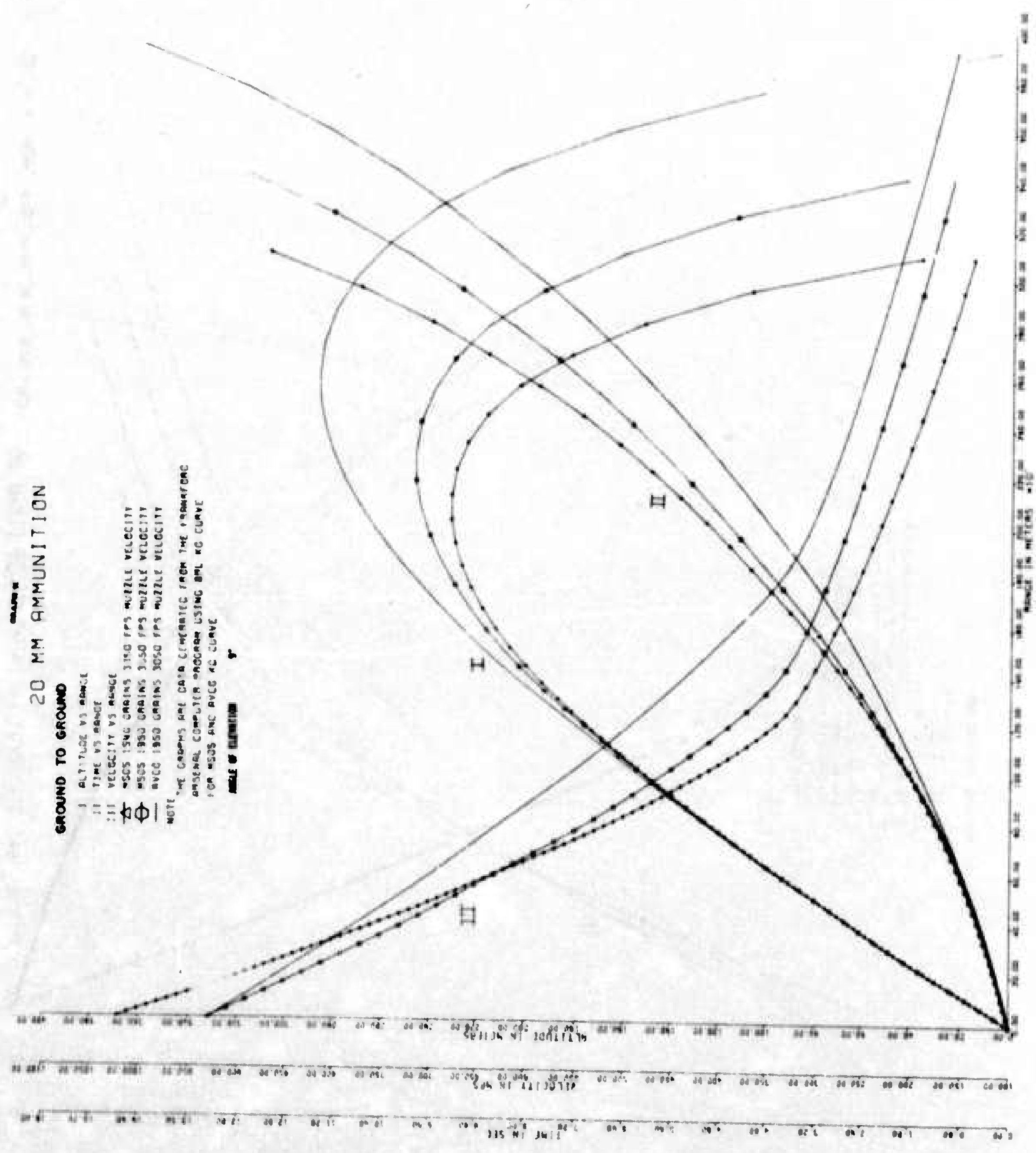


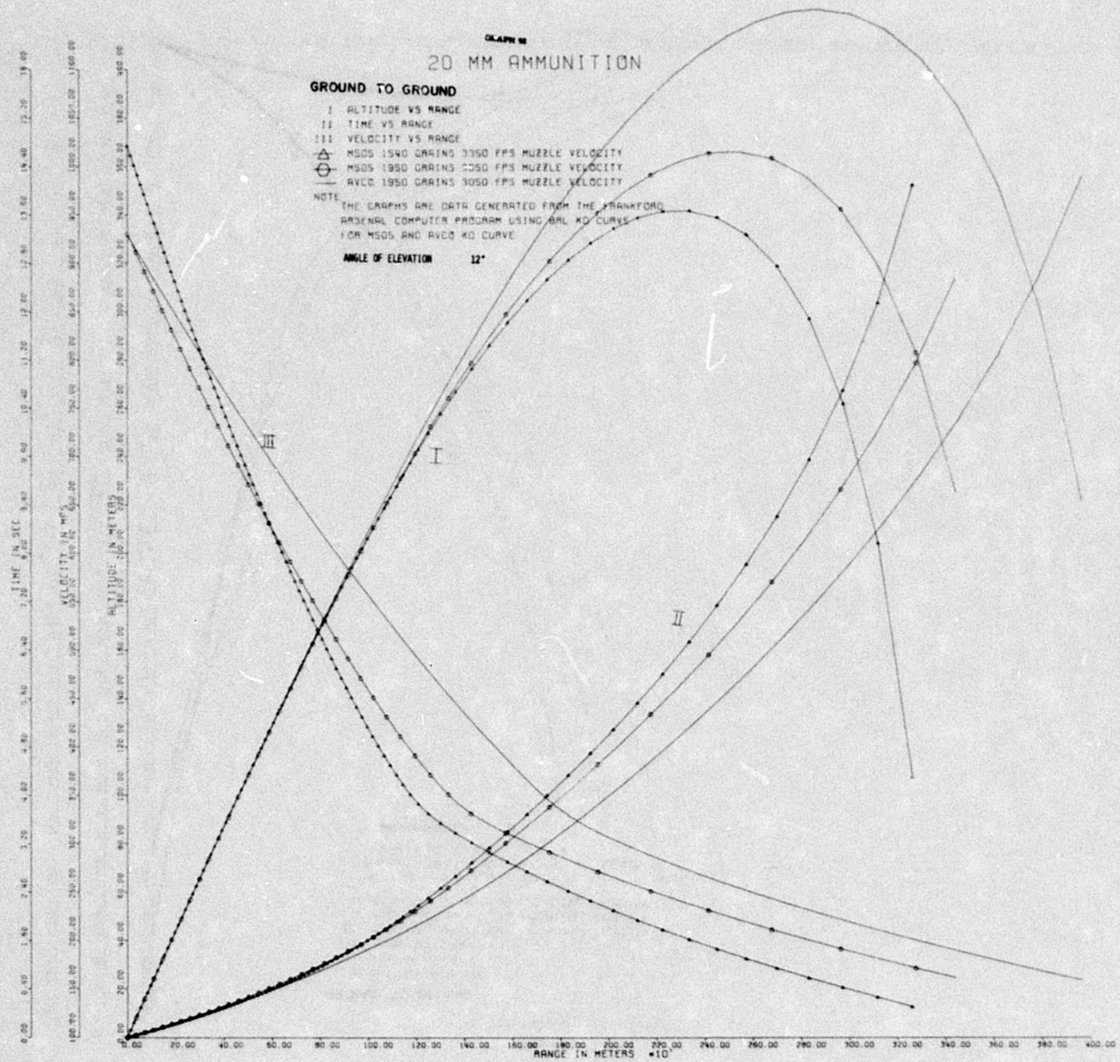
20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
MG05 GRAINS FPS MUZZLE VELOCITY
MG05 GRAINS FPS MUZZLE VELOCITY
AVCO GRAINS FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL AD CURVE FOR MG05 AND AVCO AD CURVE
ANGLE OF ELEVATION
I
II
III
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS

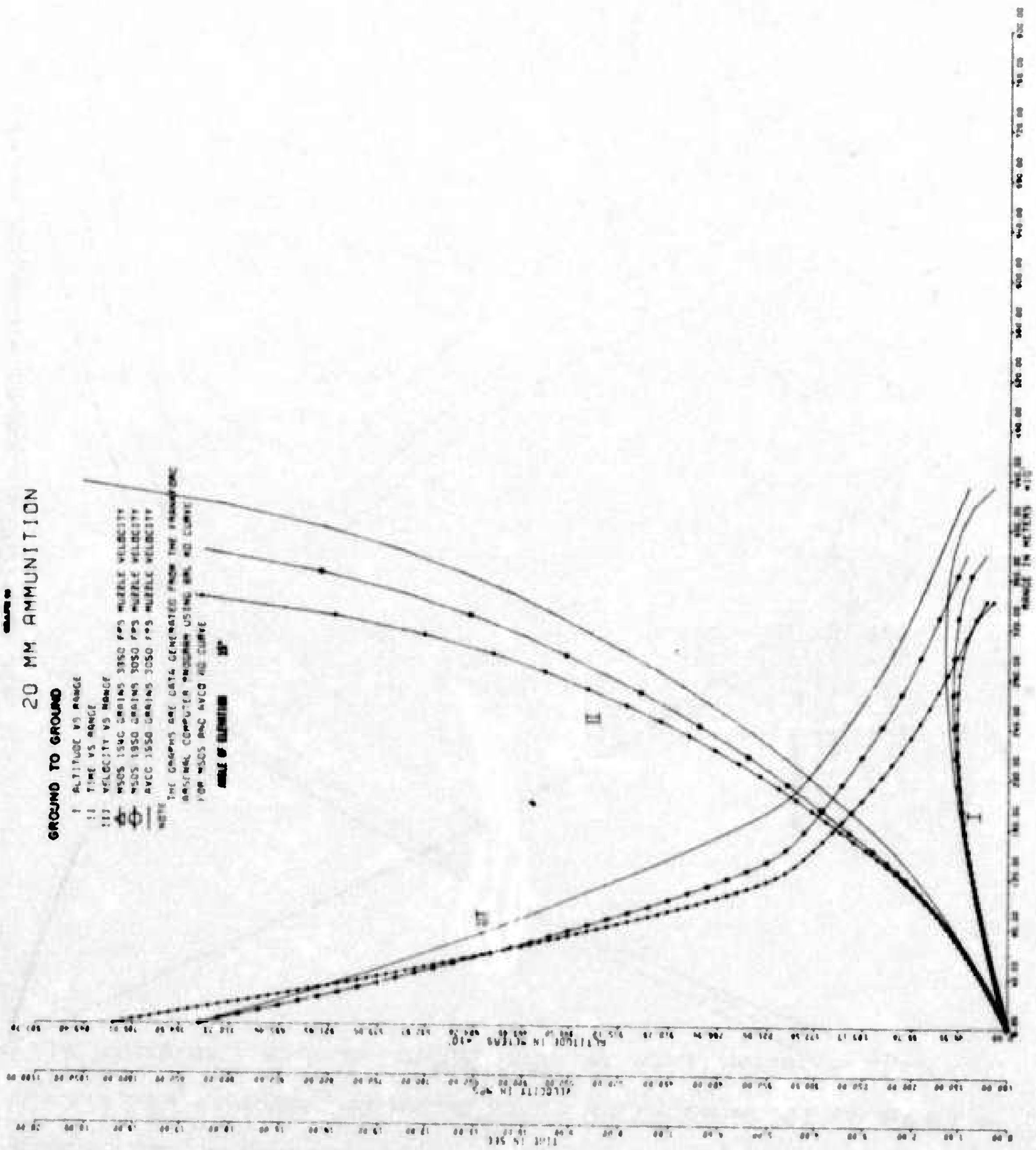

20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
I
II
III
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC

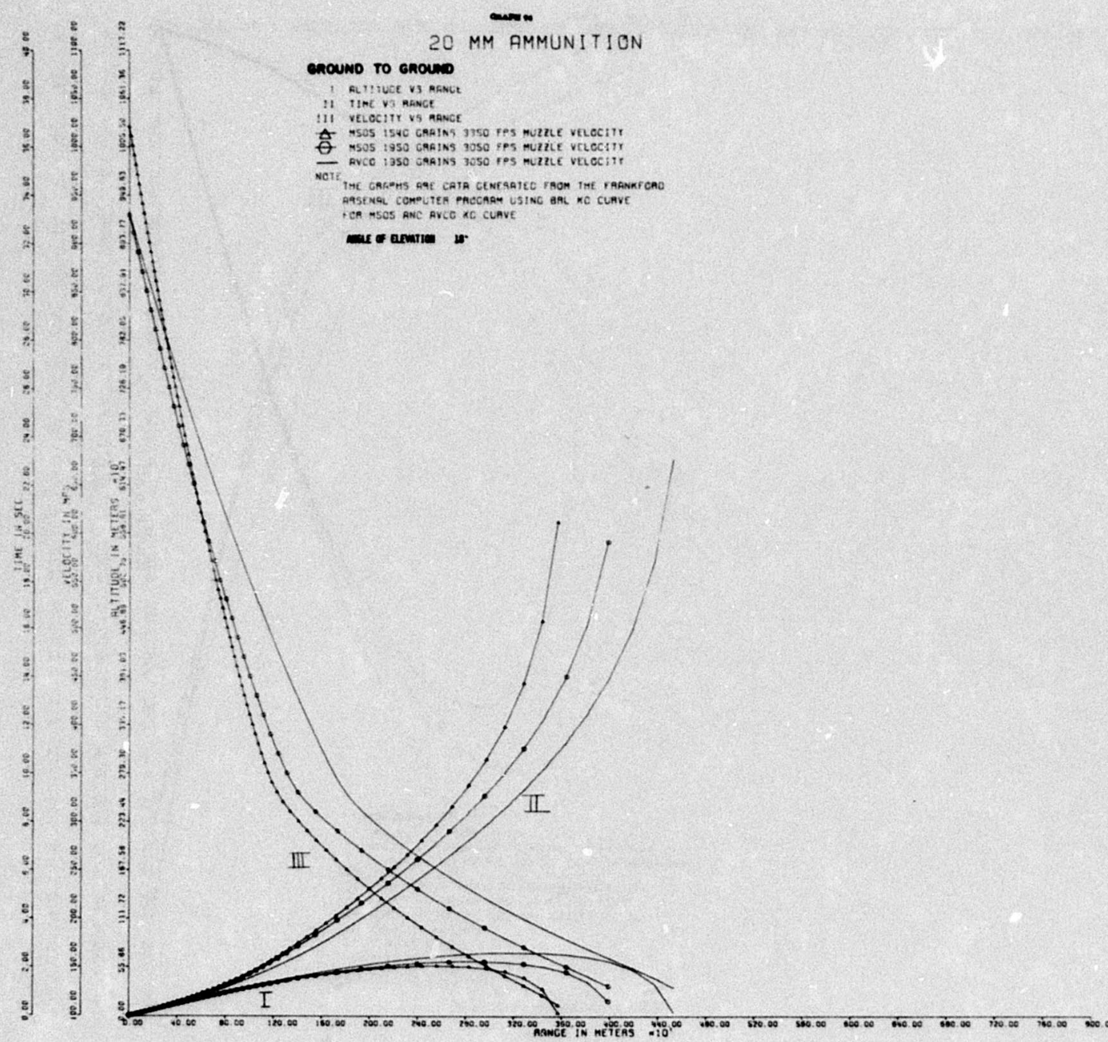

20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
MSOS 1550 GRAINS 3350 FPS MUZZLE VELOCITY
MSOS 1950 GRAINS 3050 FPS MUZZLE VELOCITY
AVCO 1950 GRAINS 3050 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BAL KD CURVE FOR MSOS AND AVCO KD CURVE
ANGLE OF ELEVATION 3°
I
II
III
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS


20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M505 1540 GRAINS 3350 FPS MUZZLE VELOCITY
M505 1550 GRAINS 3050 FPS MUZZLE VELOCITY
AVCO 1550 GRAINS 3050 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M505 AND AVCO KD CURVE
ANGLE OF ELEVATION
I
II
III
RANGE IN METERS
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS

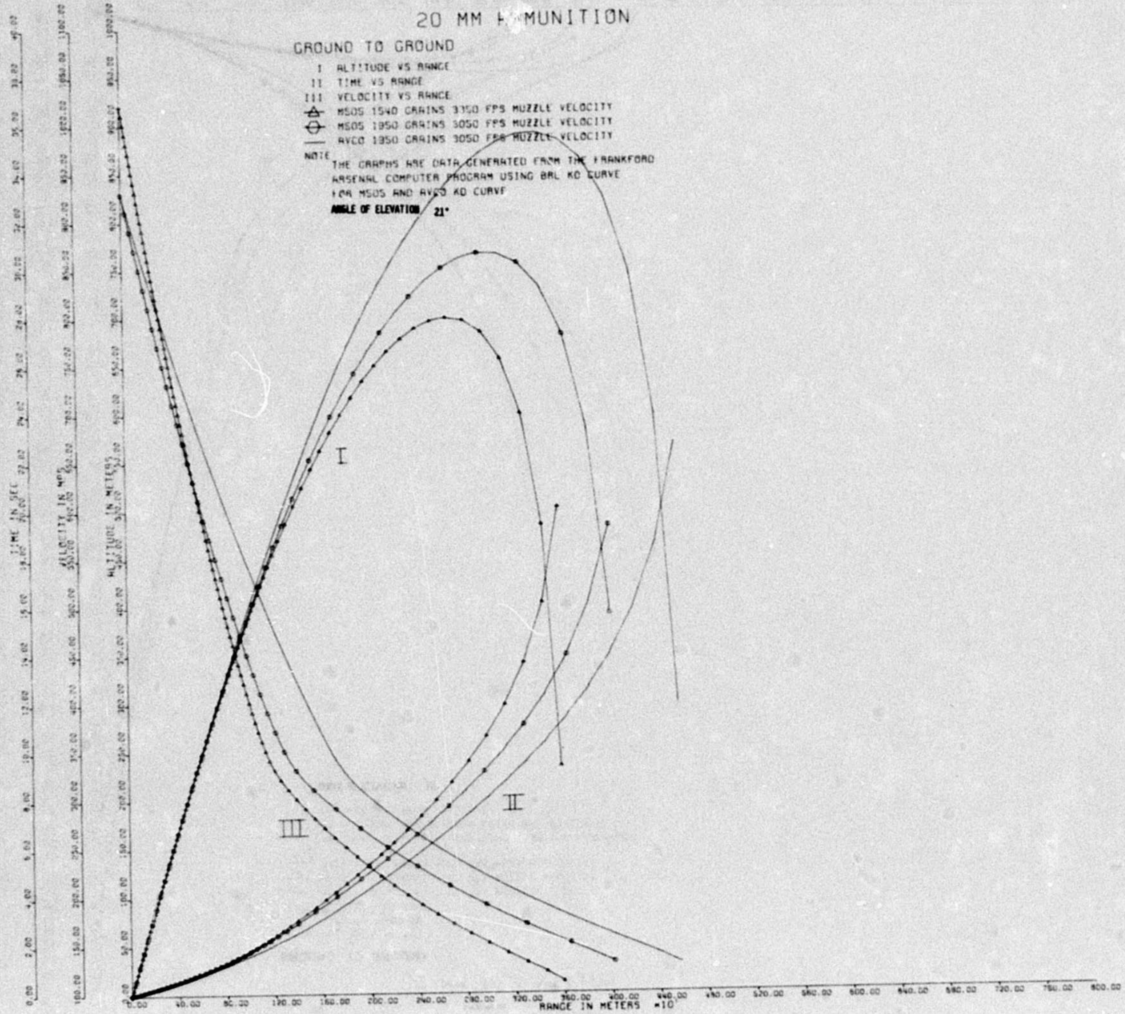

20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC
RANGE IN METERS

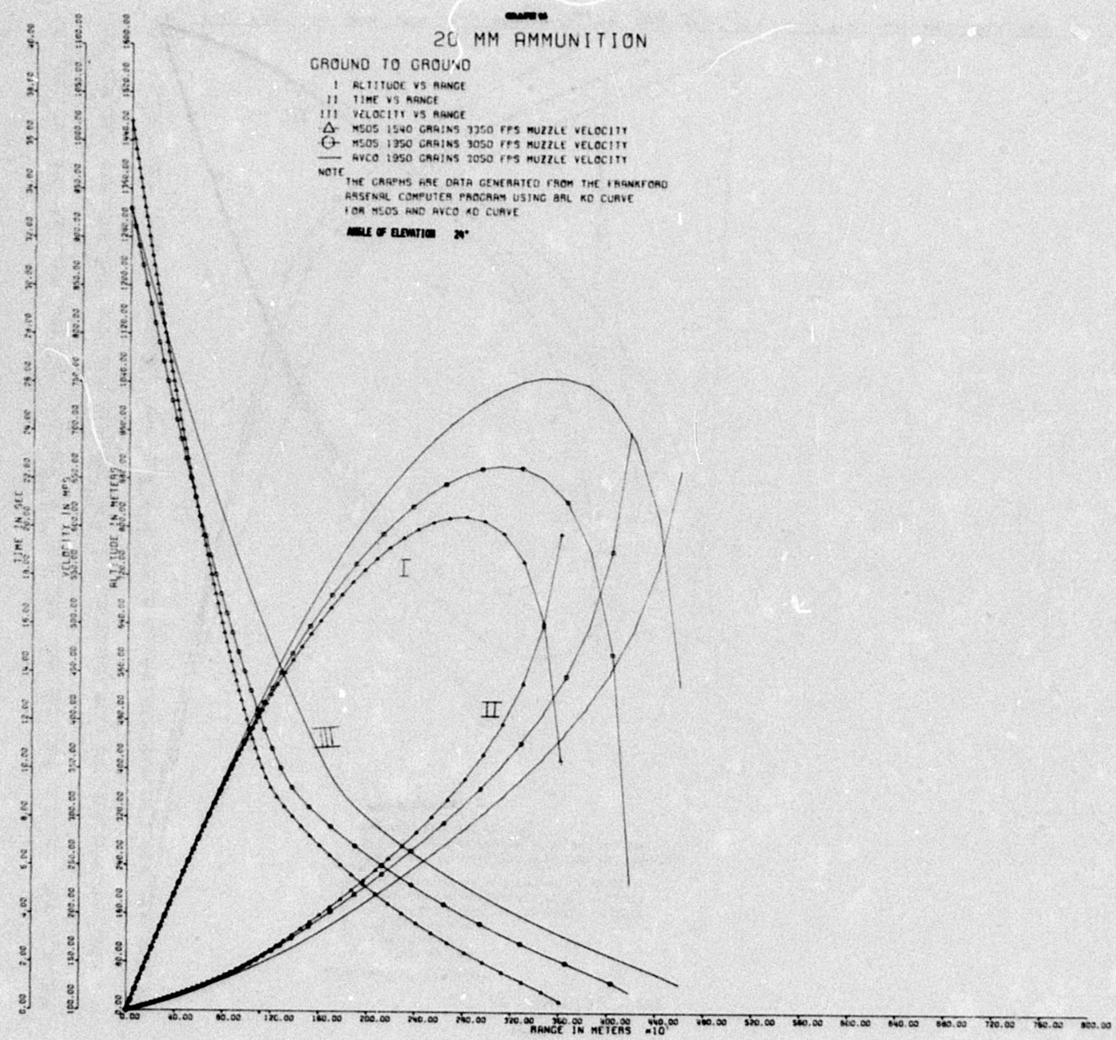

20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
MSDS 1540 GRAINS 3350 FPS MUZZLE VELOCITY
MSDS 1950 GRAINS 3050 FPS MUZZLE VELOCITY
AVCO 1950 GRAINS 3050 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BAL KD CURVE FOR MSDS AND AVCO KD CURVE
ANGLE OF ELEVATION 12°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS *10¹

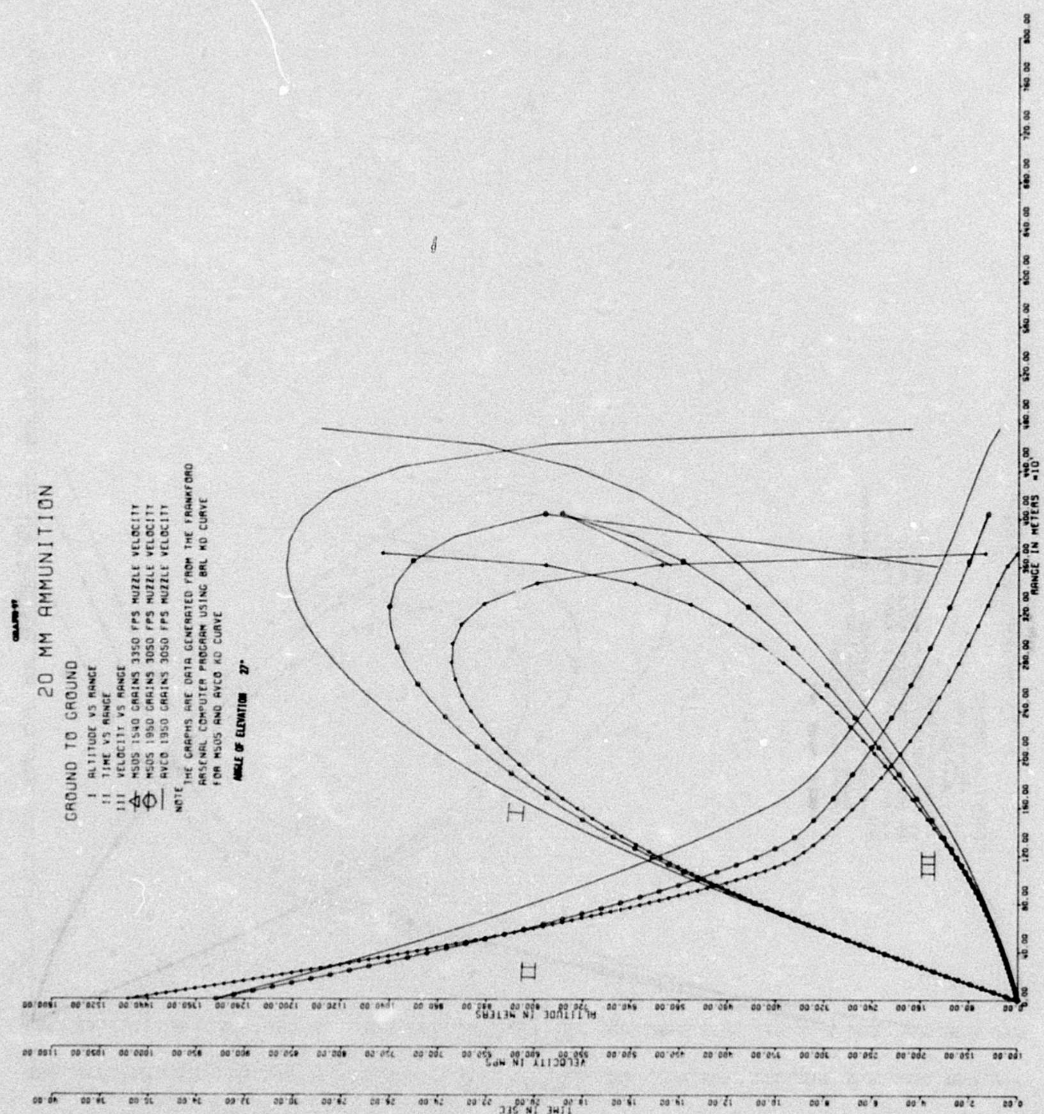

20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
MSDS 1540 GRAINS 3350 FPS MUZZLE VELOCITY
MSDS 1550 GRAINS 3050 FPS MUZZLE VELOCITY
AVCO 1550 GRAINS 3050 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR MSDS AND AVCO KD CURVE
ANGLE OF ELEVATION
RANGE IN METERS
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC
I
II
III

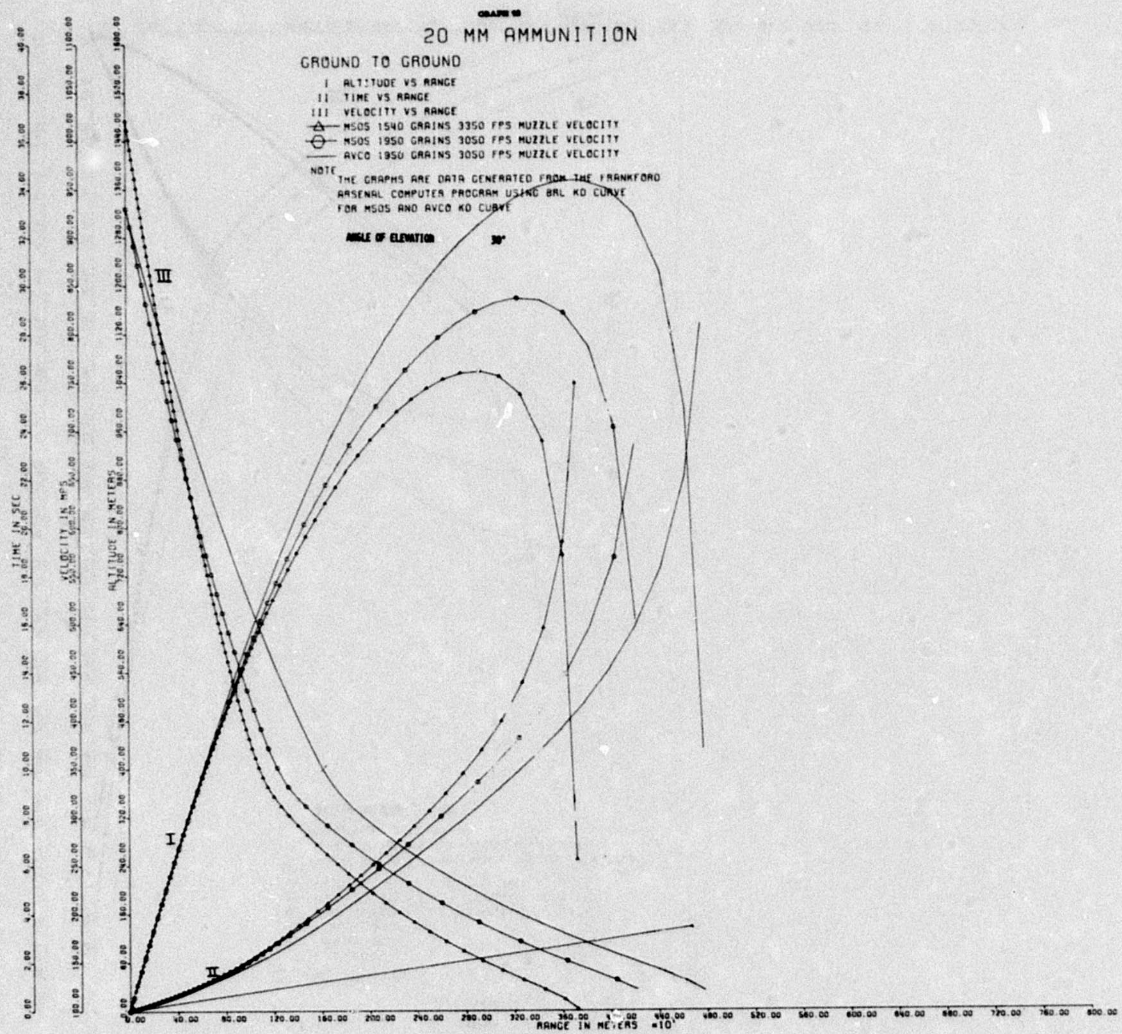

20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
MSOS 1540 GRAINS 3350 FPS MUZZLE VELOCITY
MSOS 1950 GRAINS 3050 FPS MUZZLE VELOCITY
AVCO 1350 GRAINS 3050 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR MSOS AND AVCO KD CURVE
ANGLE OF ELEVATION 10°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS ×10
RANGE IN METERS ×10
I
II
III

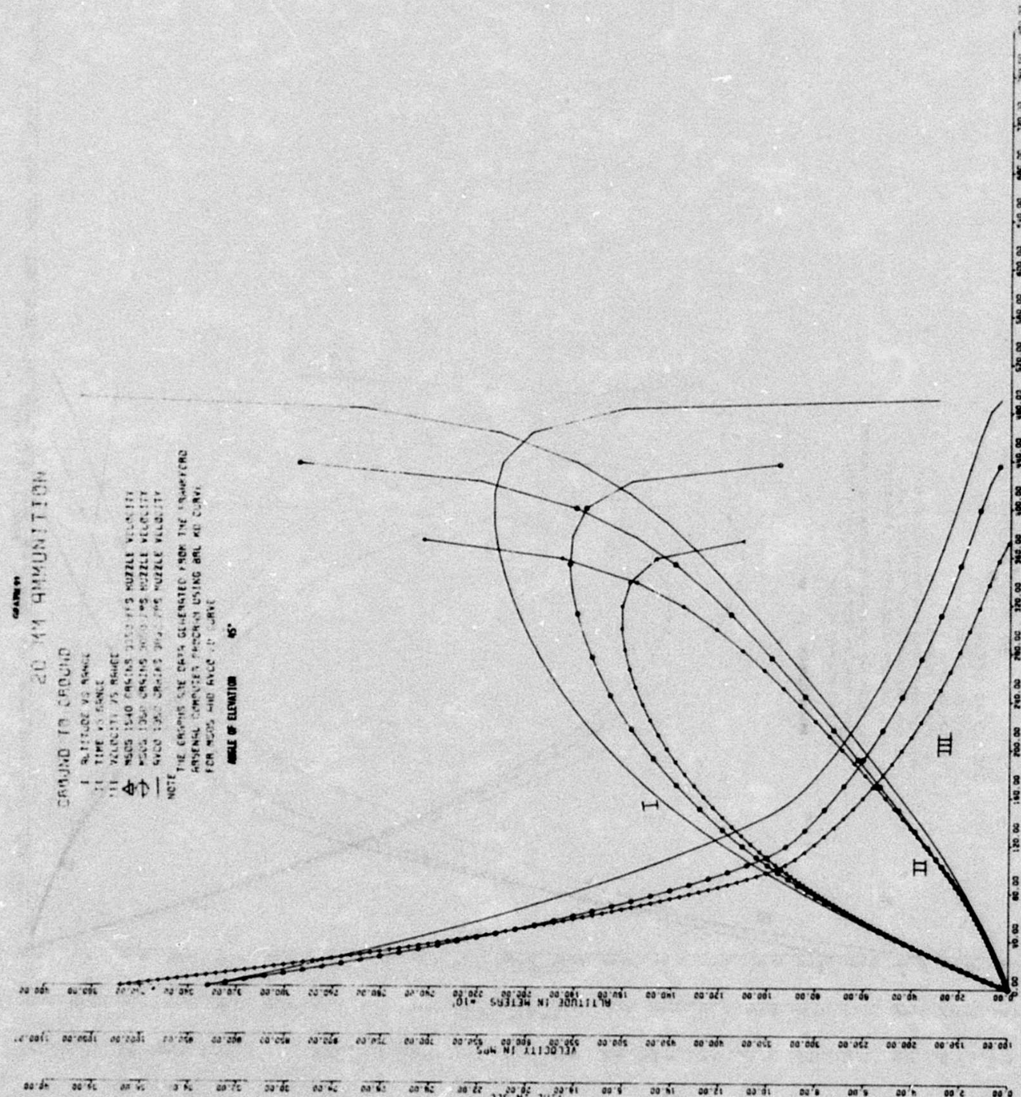
[redacted]


20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
MSOS 1540 GRAINS 3150 FPS MUZZLE VELOCITY
MSOS 1950 GRAINS 3050 FPS MUZZLE VELOCITY
AVCO 1950 GRAINS 3050 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR MSOS AND AVCO KD CURVE
ANGLE OF ELEVATION 21°
I
II
III
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS *10

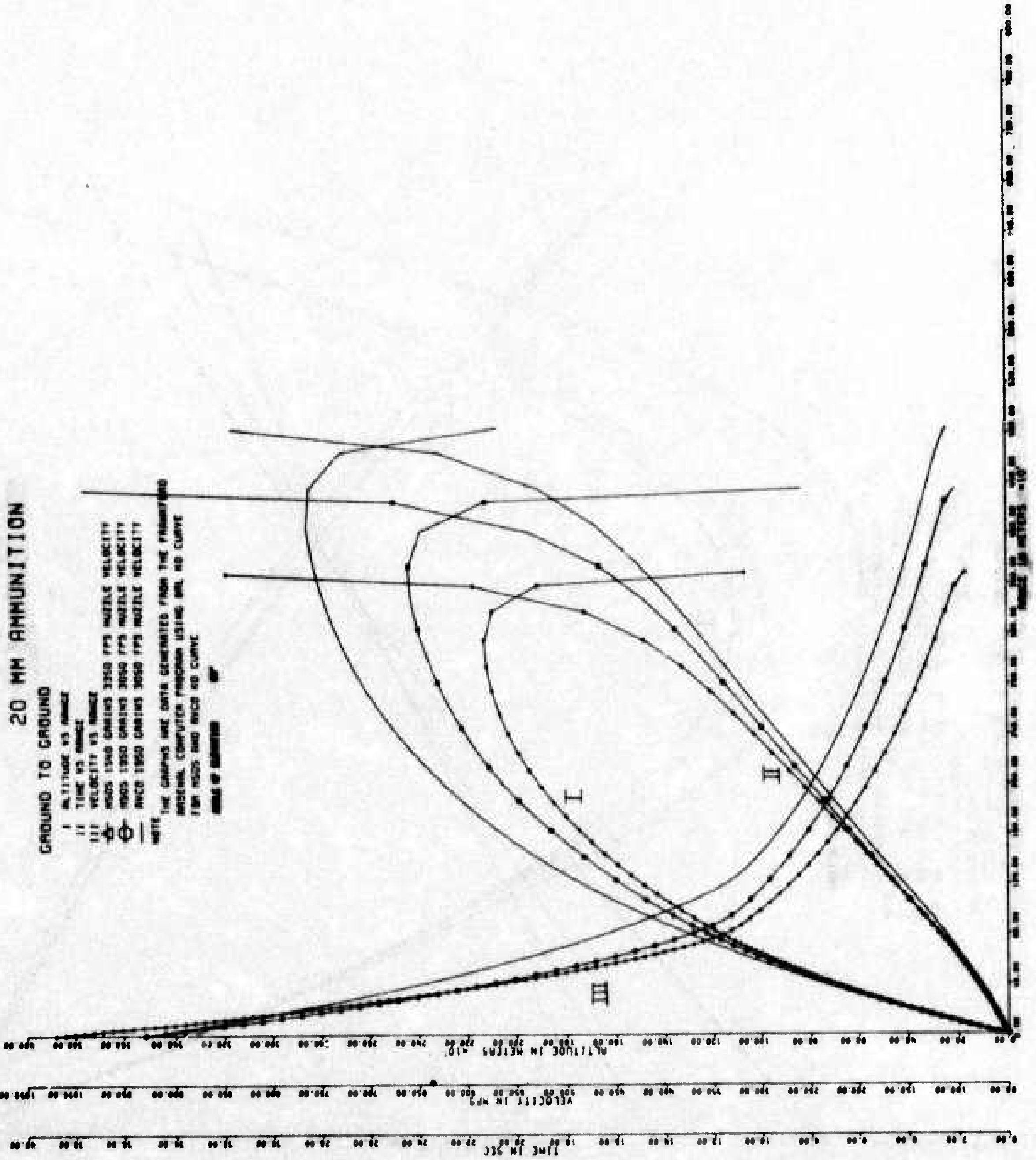

20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
MSOS 1540 GRAINS 3350 FPS MUZZLE VELOCITY
MSOS 1350 GRAINS 3050 FPS MUZZLE VELOCITY
AVCO 1950 GRAINS 3050 FPS MUZZLE VELOCITY
NOTE THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR MSOS AND AVCO KD CURVE
ANGLE OF ELEVATION 20°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS *10
I
II
III

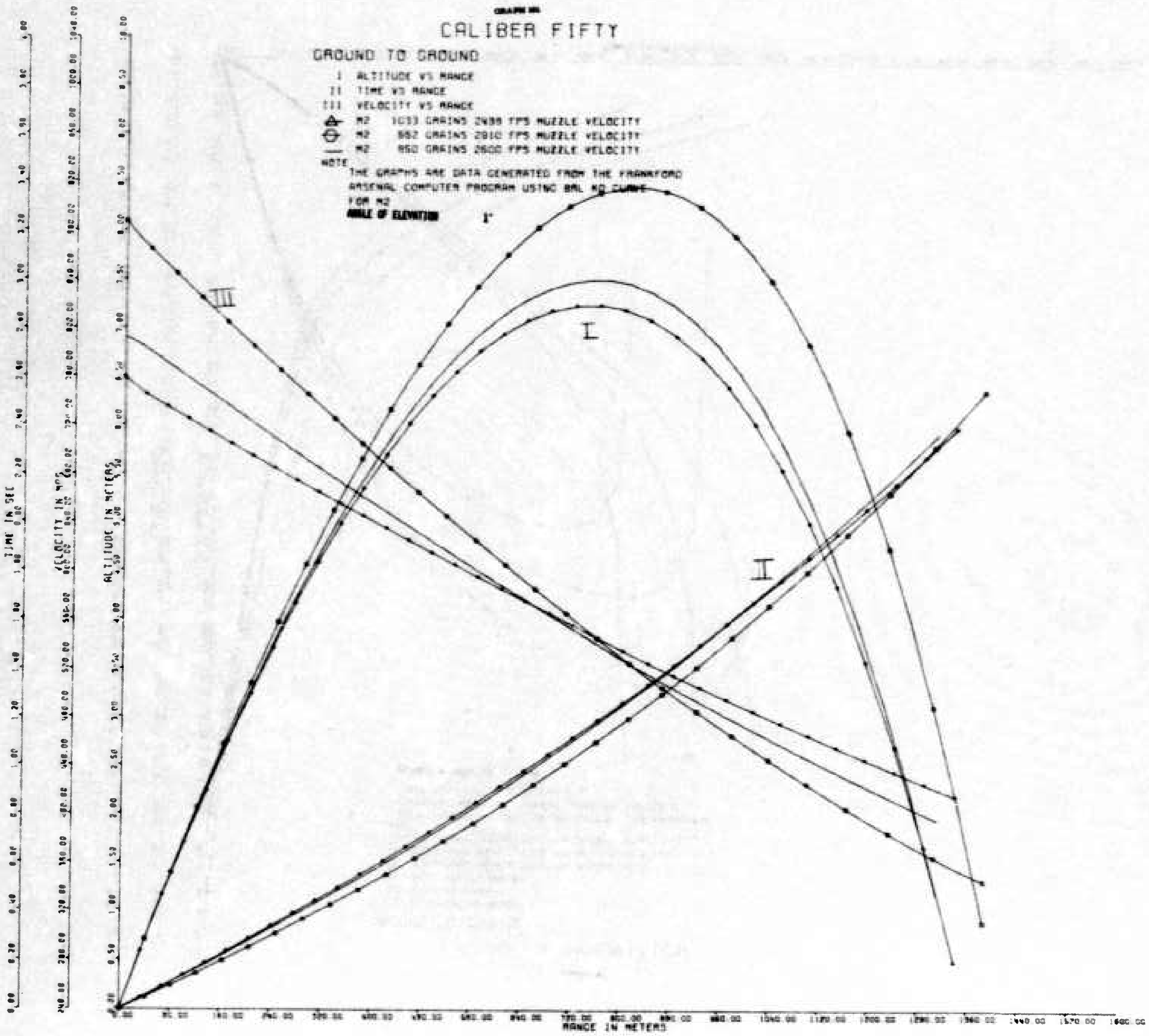

20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
MSOS 1540 GRAINS 3350 FPS MUZZLE VELOCITY
MSOS 1950 GRAINS 3050 FPS MUZZLE VELOCITY
AVCO 1950 GRAINS 3050 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR MSOS AND AVCO KD CURVE
ANGLE OF ELEVATION 27°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS

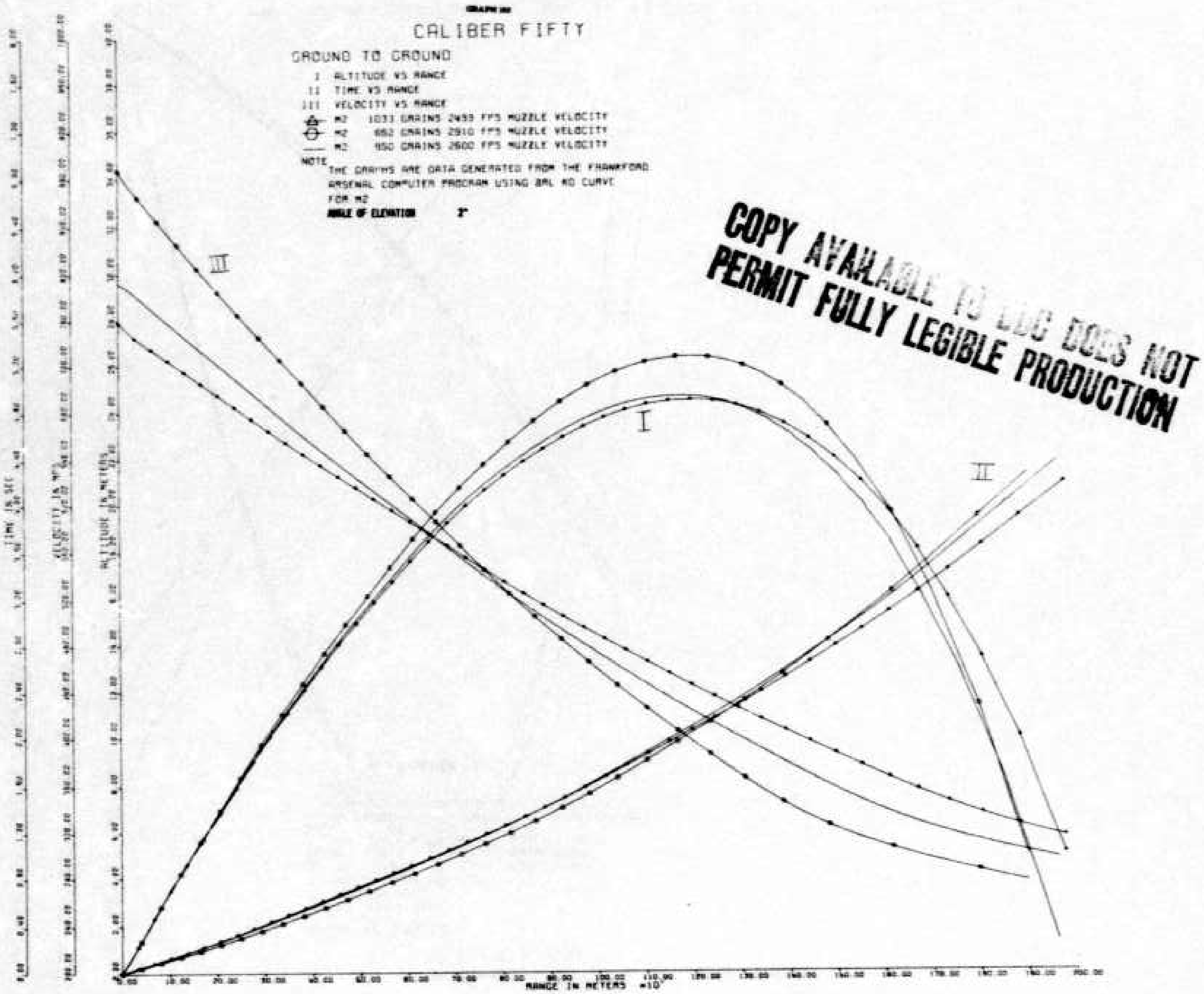

GRAPH 10
20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
MSOS 1540 GRAINS 3350 FPS MUZZLE VELOCITY
MSOS 1950 GRAINS 3050 FPS MUZZLE VELOCITY
AVCO 1950 GRAINS 3050 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR MSOS AND AVCO KD CURVE
ANGLE OF ELEVATION 30°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS ×10¹
I
II
III

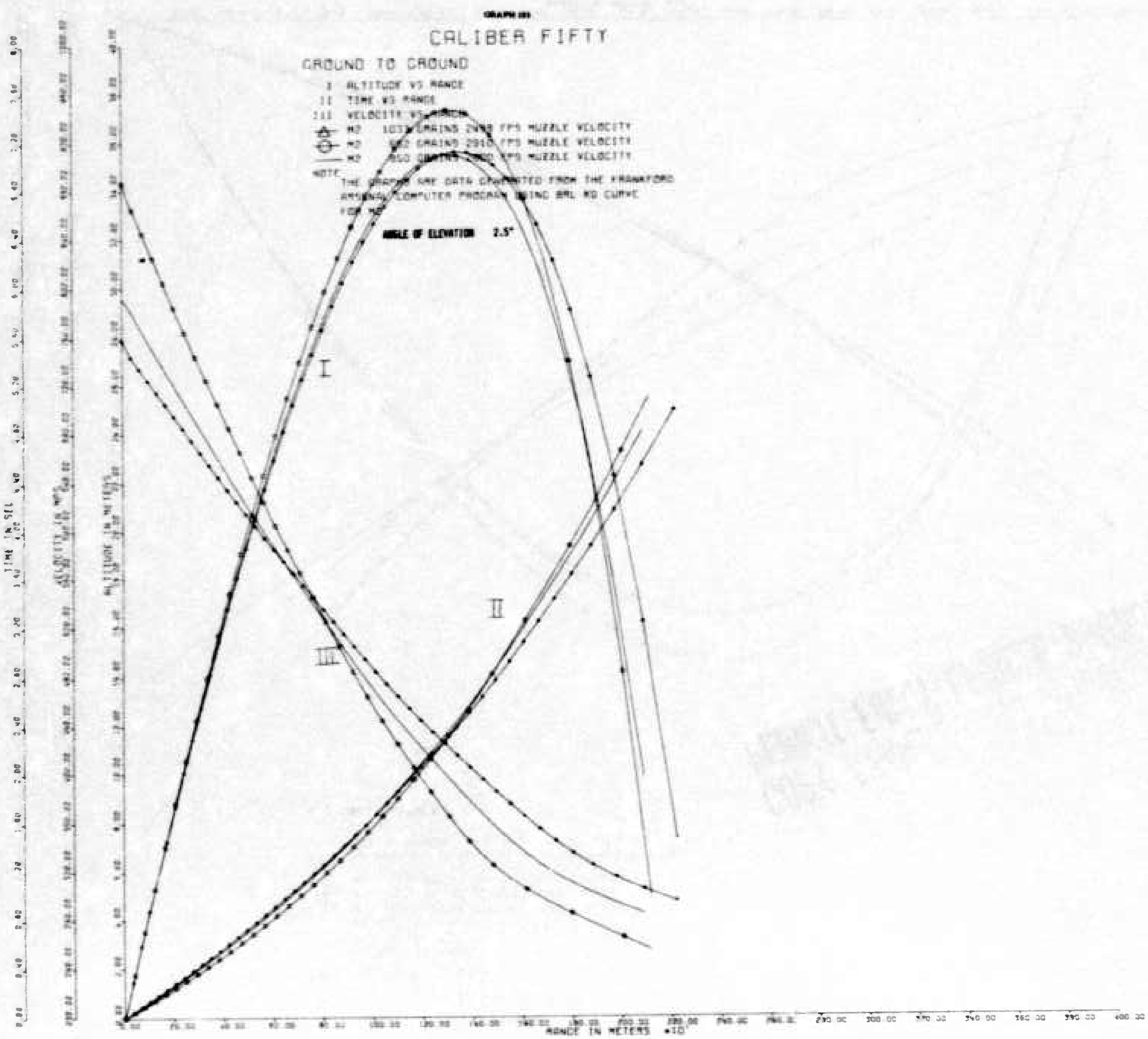


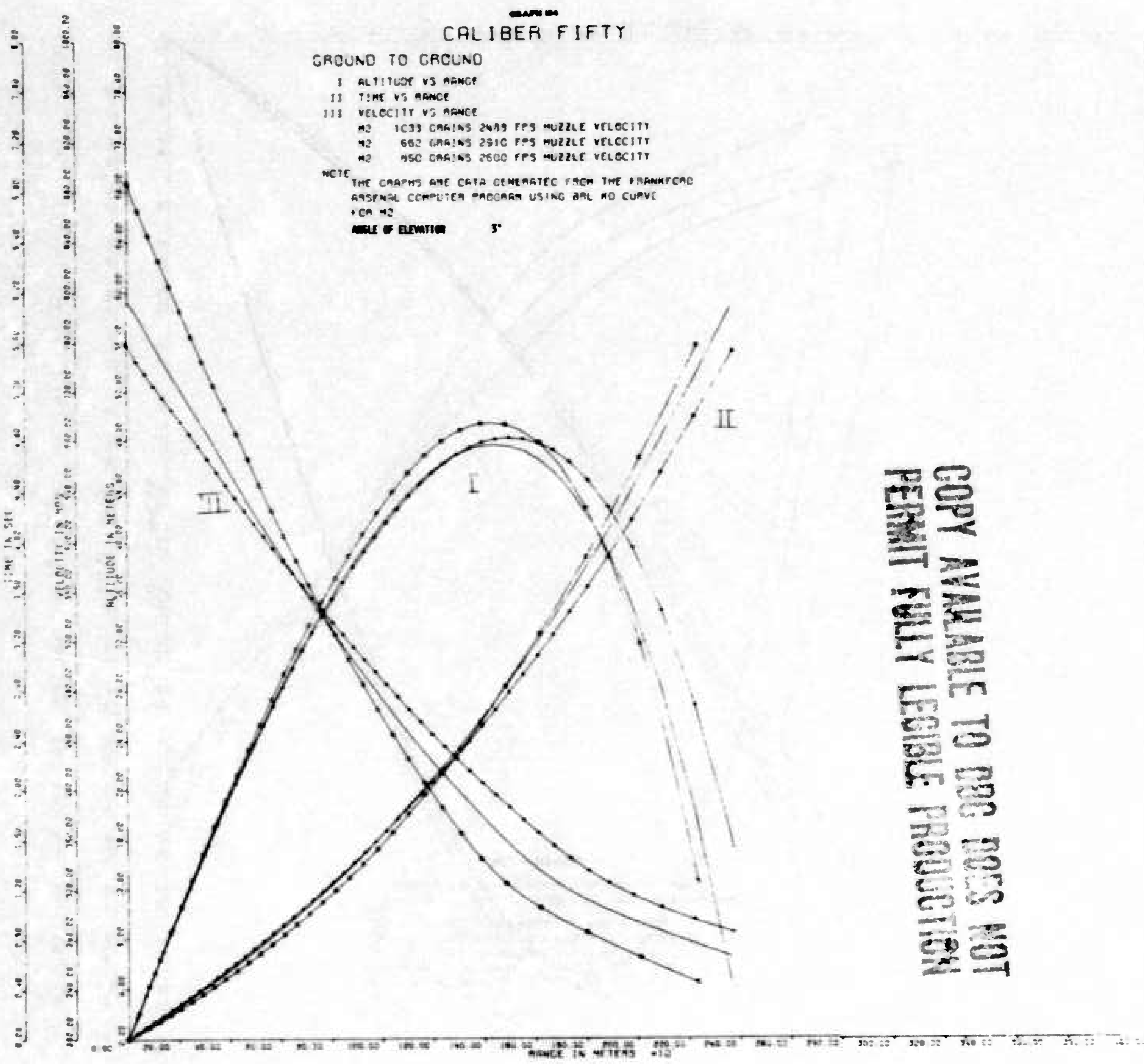
20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
ANGLE OF ELEVATION 45°
ALTITUDE IN METERS *10
VELOCITY IN MPS
TIME IN SEC
RANGE IN METERS *10
I
II
III

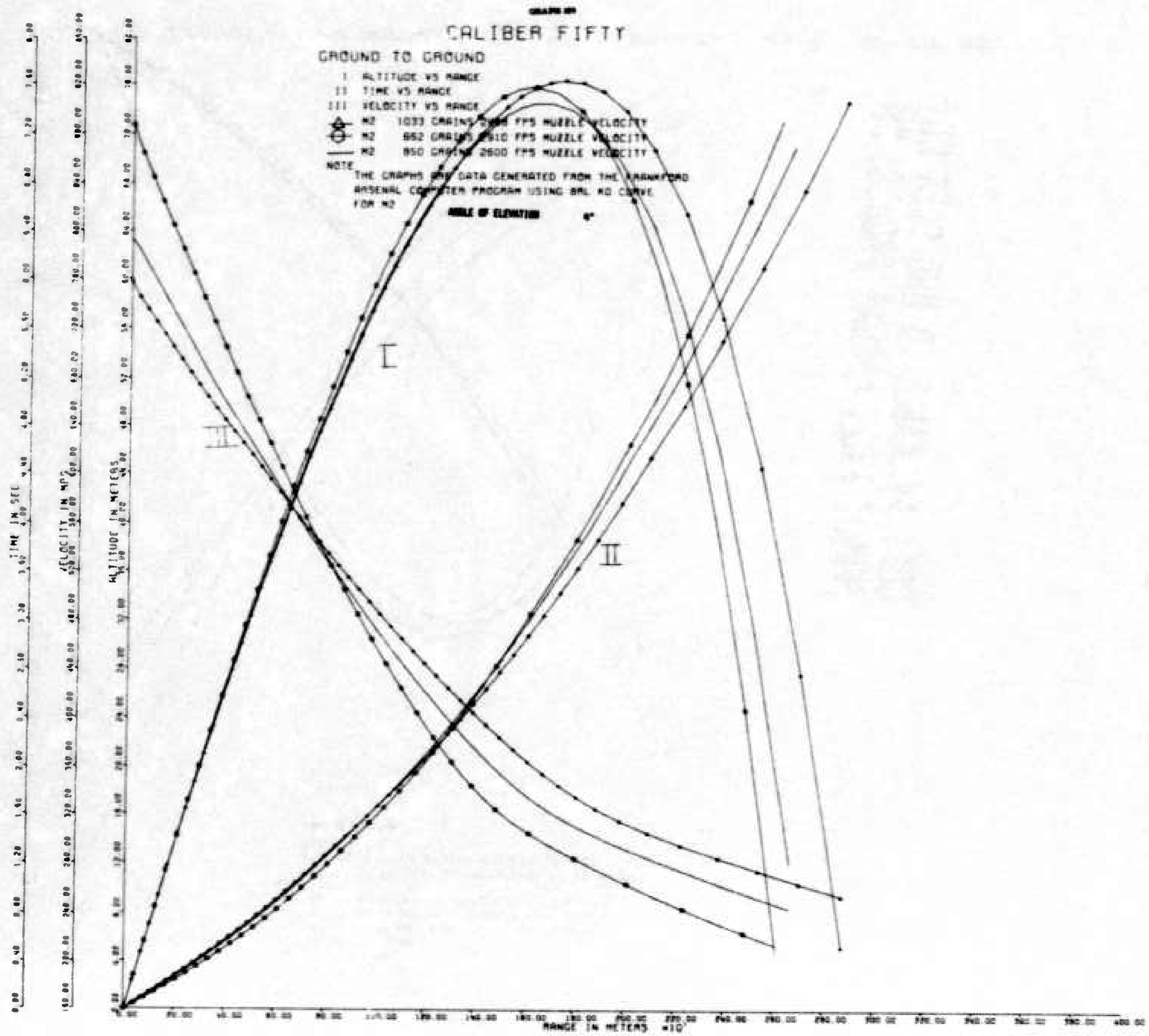

20 MM AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M505 1540 GRAINS 3350 FPS MUZZLE VELOCITY
M505 1950 GRAINS 3050 FPS MUZZLE VELOCITY
AVCO 1950 GRAINS 3050 FPS MUZZLE VELOCITY
NOTE THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M505 AND AVCO KD CURVE
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS ×10
RANGE IN METERS ×10
I
II
III

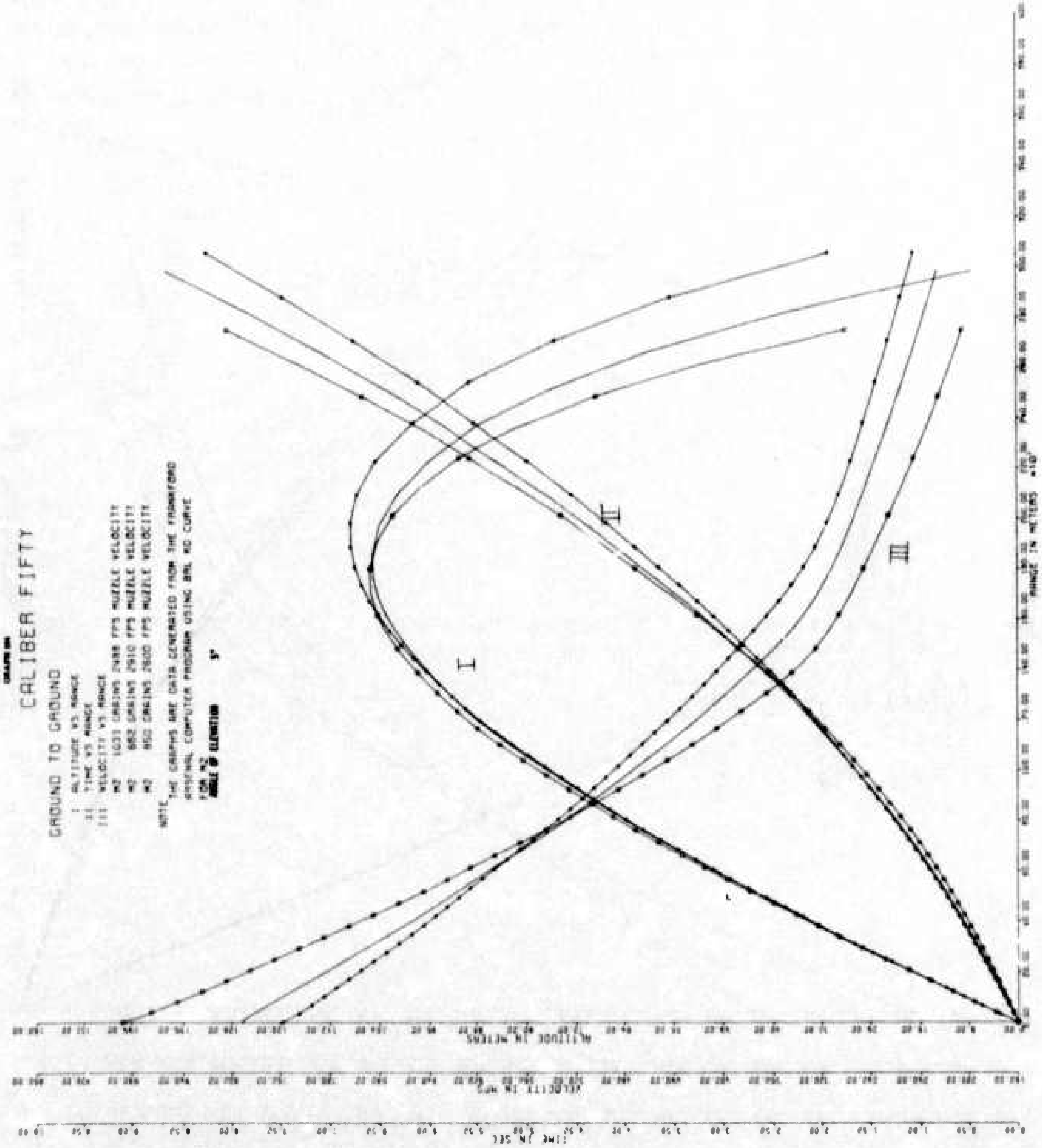

CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M2 1033 GRAINS 2499 FPS MUZZLE VELOCITY
M2 662 GRAINS 2810 FPS MUZZLE VELOCITY
M2 950 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE: THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M2
ANGLE OF ELEVATION 1°
I
II
III
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS

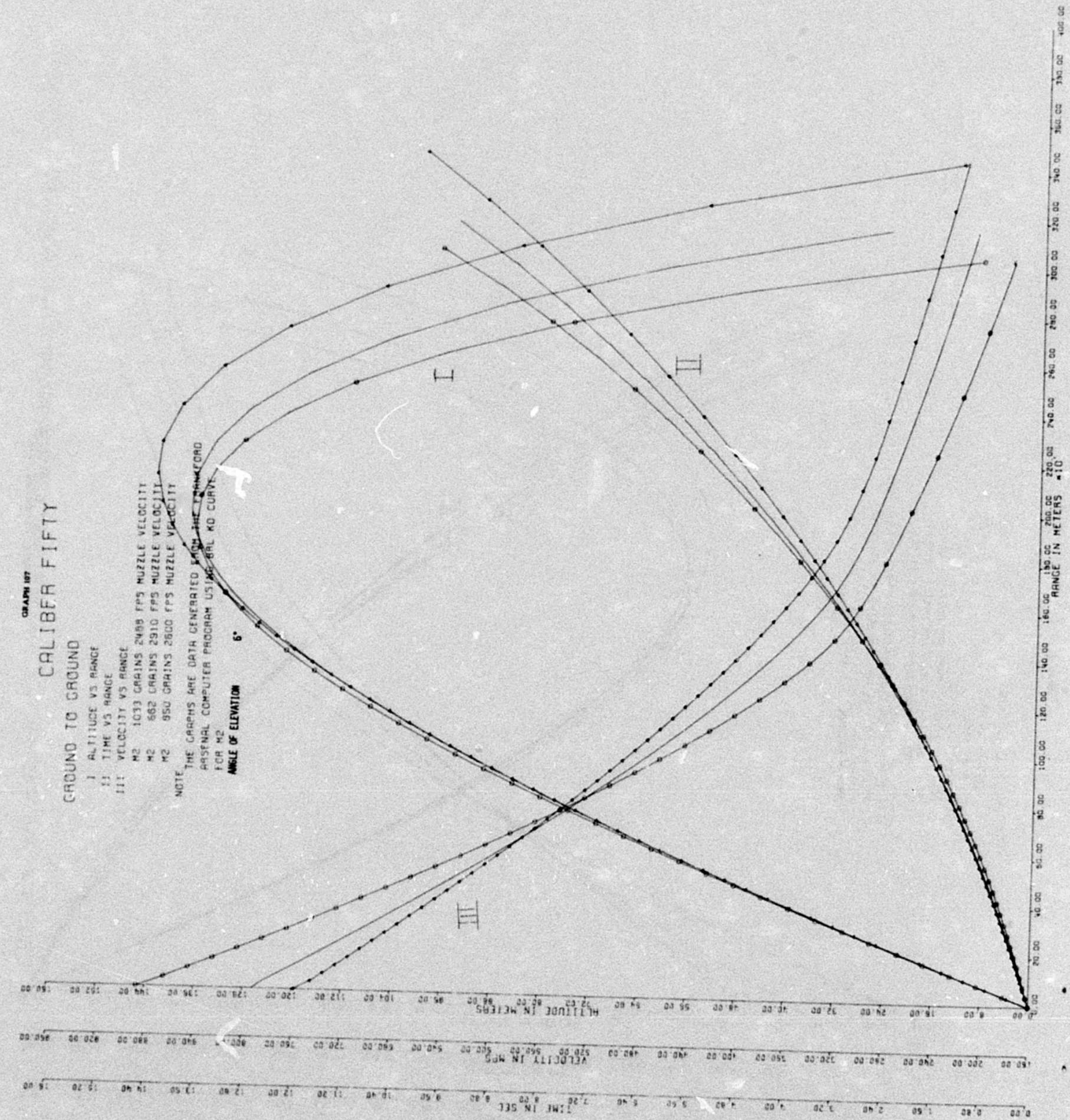

CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M2 1033 GRAINS 2499 FPS MUZZLE VELOCITY
M2 662 GRAINS 2910 FPS MUZZLE VELOCITY
M2 950 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M2
ANGLE OF ELEVATION 3°
I
II
III
RANGE IN METERS ×10

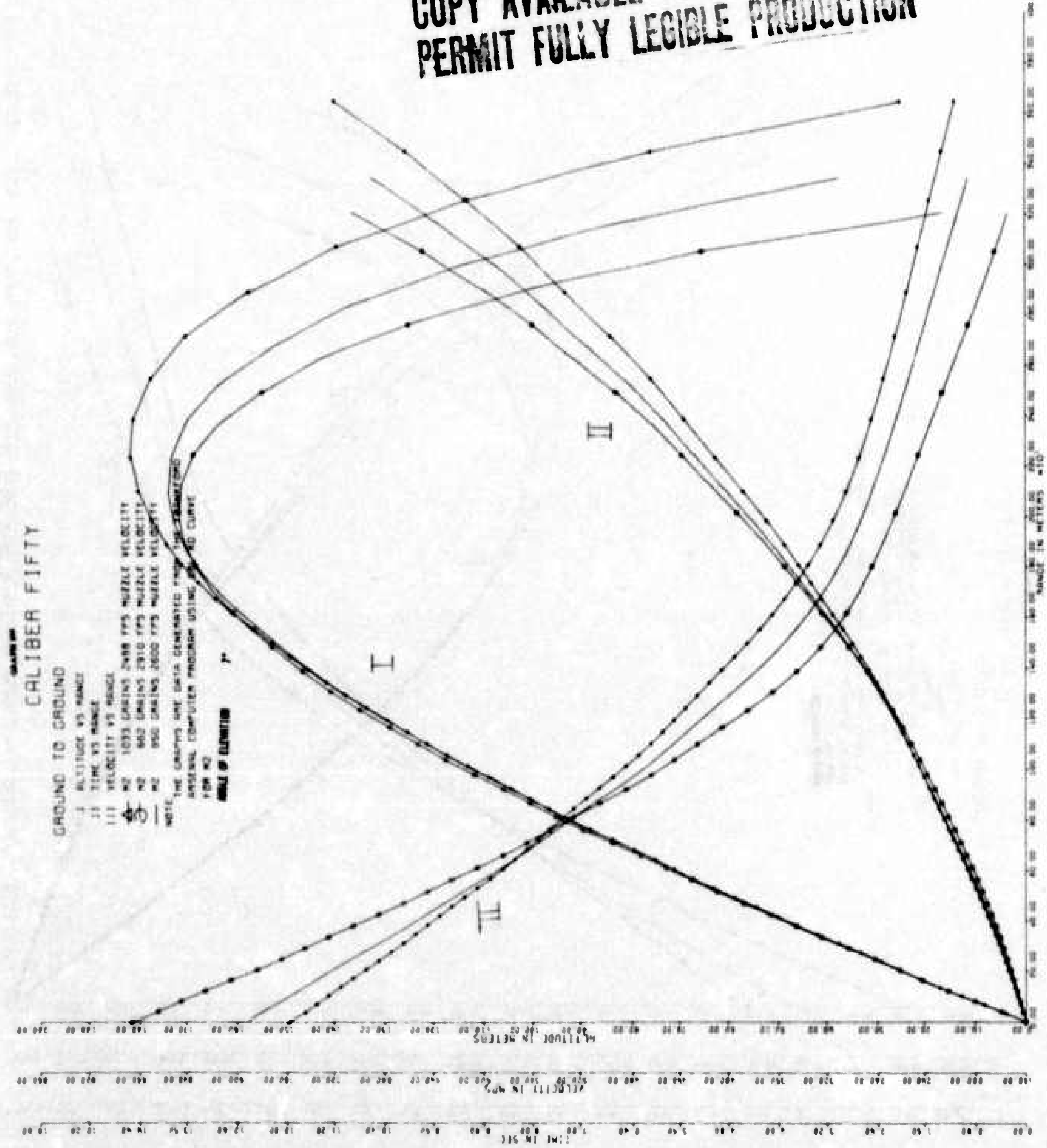

CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M2 FPS MUZZLE VELOCITY
M2 FPS MUZZLE VELOCITY
M2 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
ANGLE OF ELEVATION 2.5°
I
II
III
RANGE IN METERS *10
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS

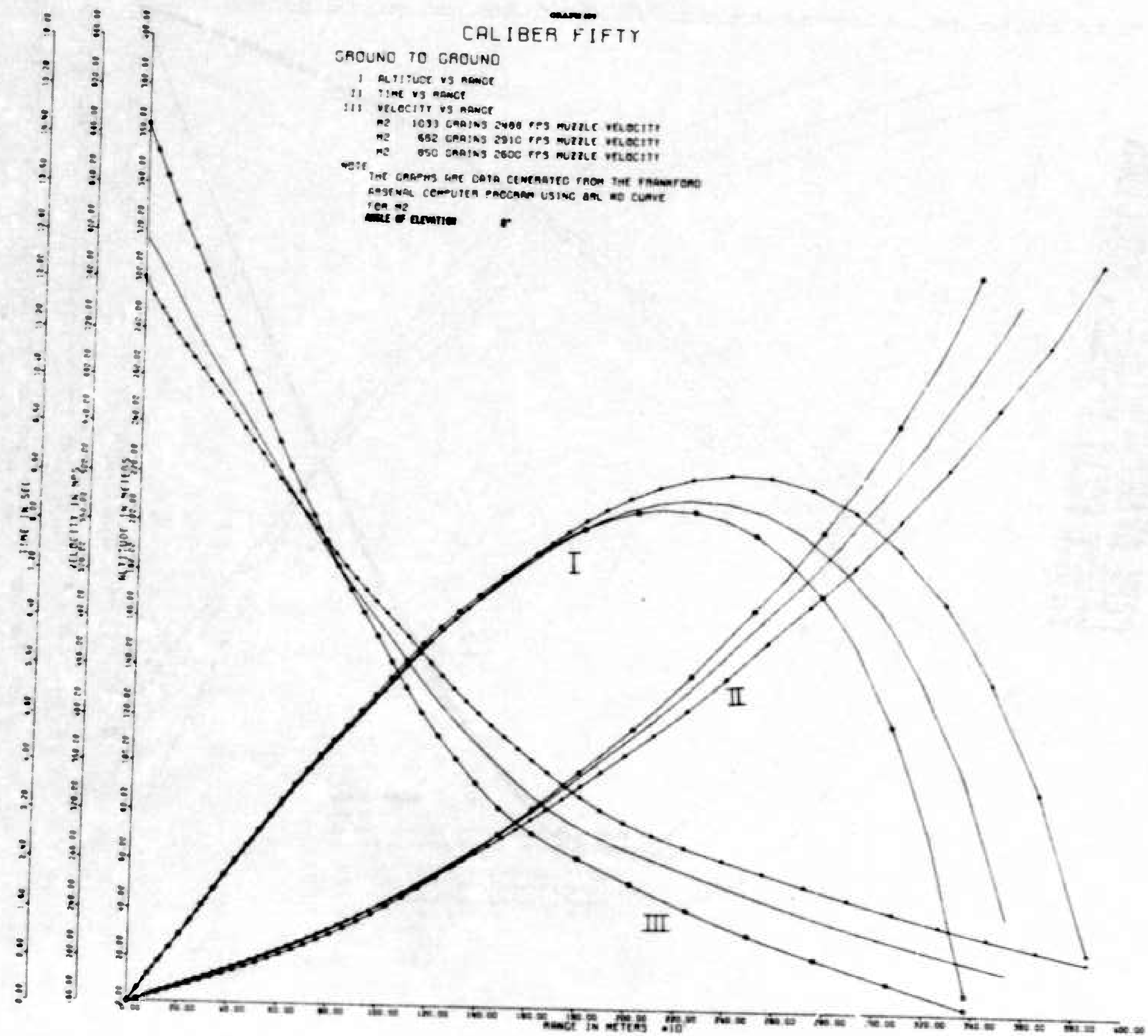

GRAPH 84
CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M2 1033 GRAINS 2489 FPS MUZZLE VELOCITY
M2 662 GRAINS 2910 FPS MUZZLE VELOCITY
M2 950 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M2
ANGLE OF ELEVATION 3°
I
II
III
RANGE IN METERS ×10
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC

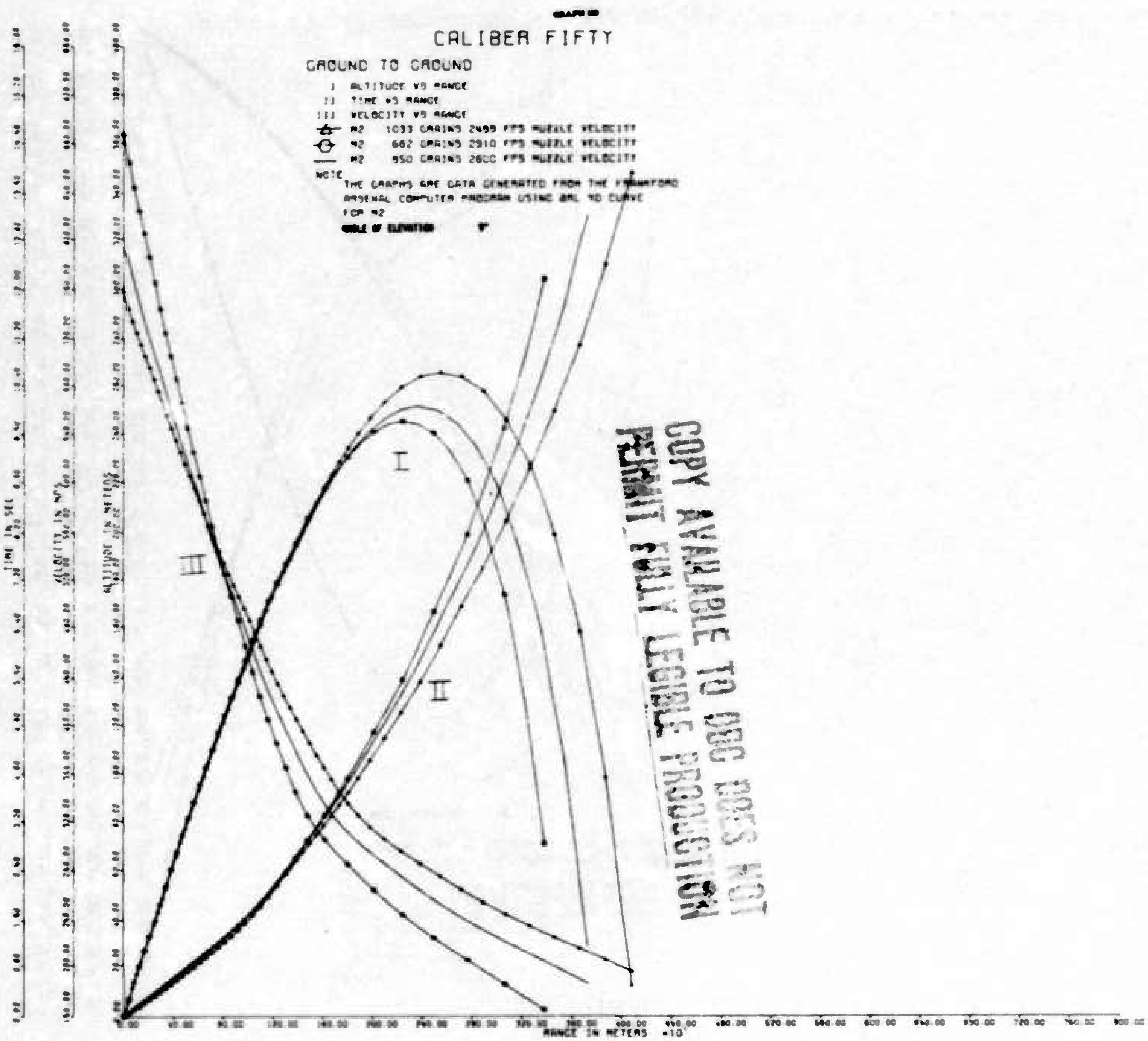

CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M2 1033 GRAINS FPS MUZZLE VELOCITY
M2 862 GRAINS FPS MUZZLE VELOCITY
M2 850 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS AND DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M2
ANGLE OF ELEVATION
I
II
III
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS

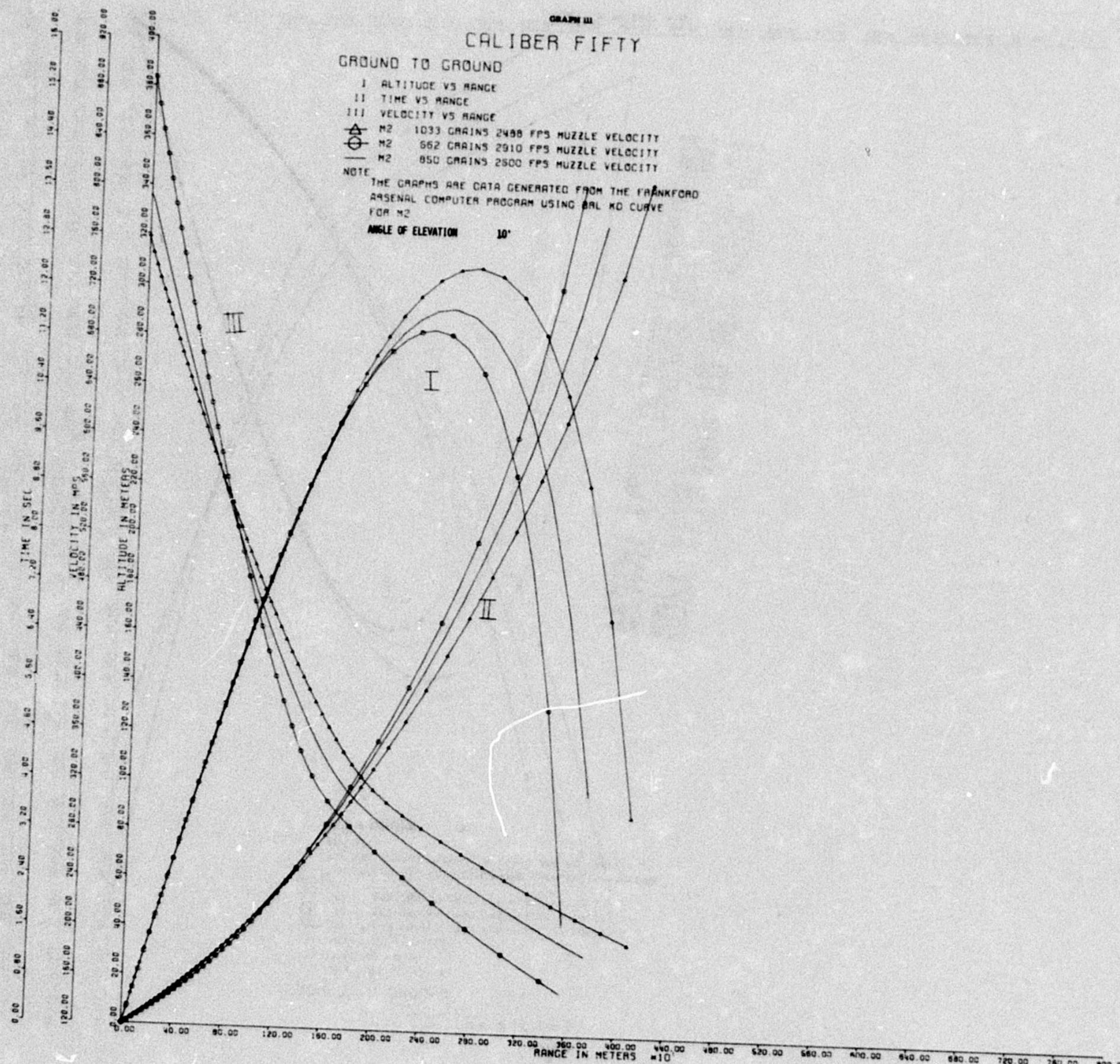

CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M2 1033 GRAINS 2488 FPS MUZZLE VELOCITY
M2 682 GRAINS 2910 FPS MUZZLE VELOCITY
M2 850 GRAINS 2800 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M2
ANGLE OF ELEVATION 5°
I
II
III
RANGE IN METERS ×10¹
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC

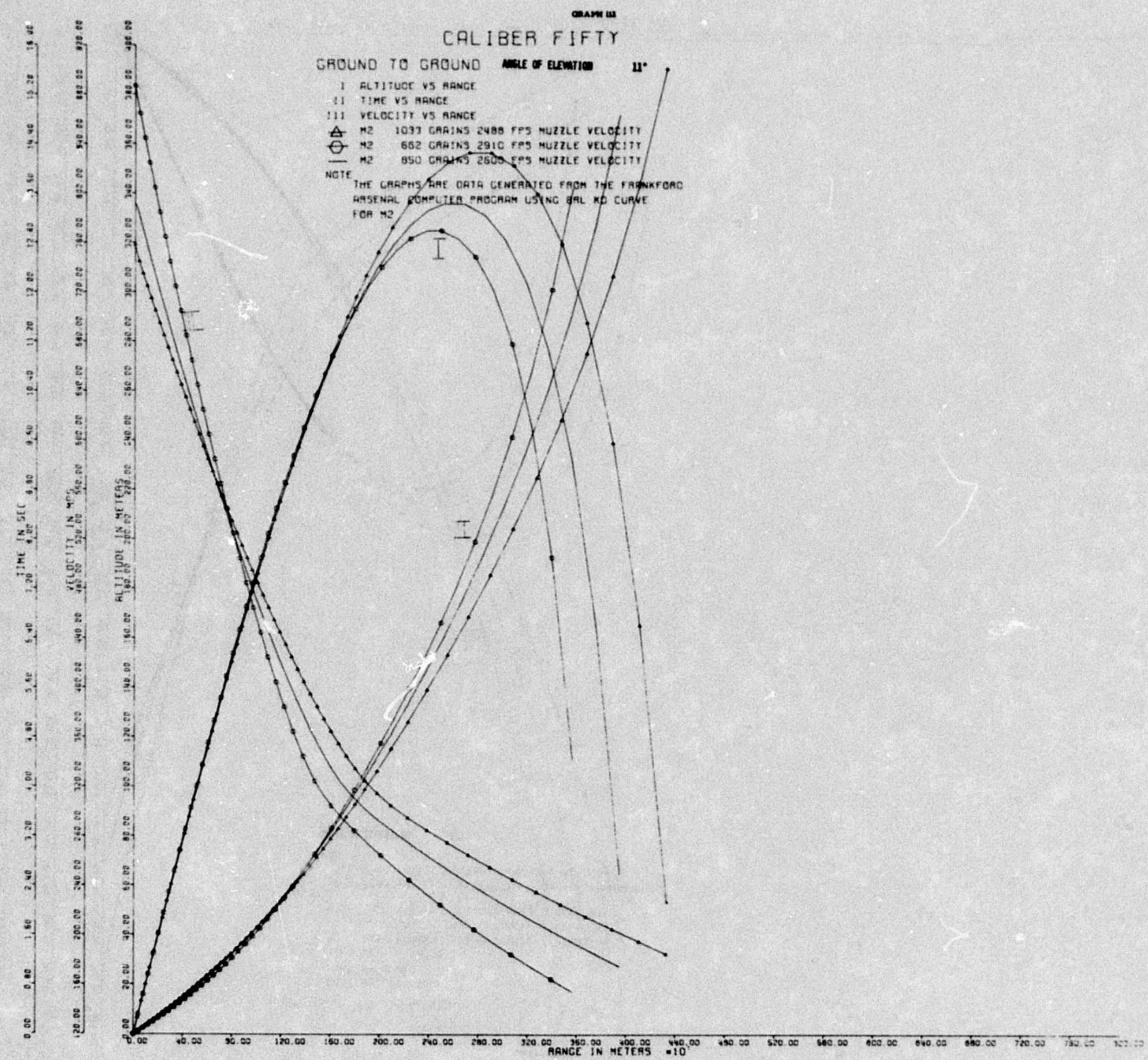

GRAPH 107
CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M2 1033 GRAINS 2488 FPS MUZZLE VELOCITY
M2 662 GRAINS 2910 FPS MUZZLE VELOCITY
M2 950 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M2
ANGLE OF ELEVATION 6°
I
II
III
RANGE IN METERS ×10
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC

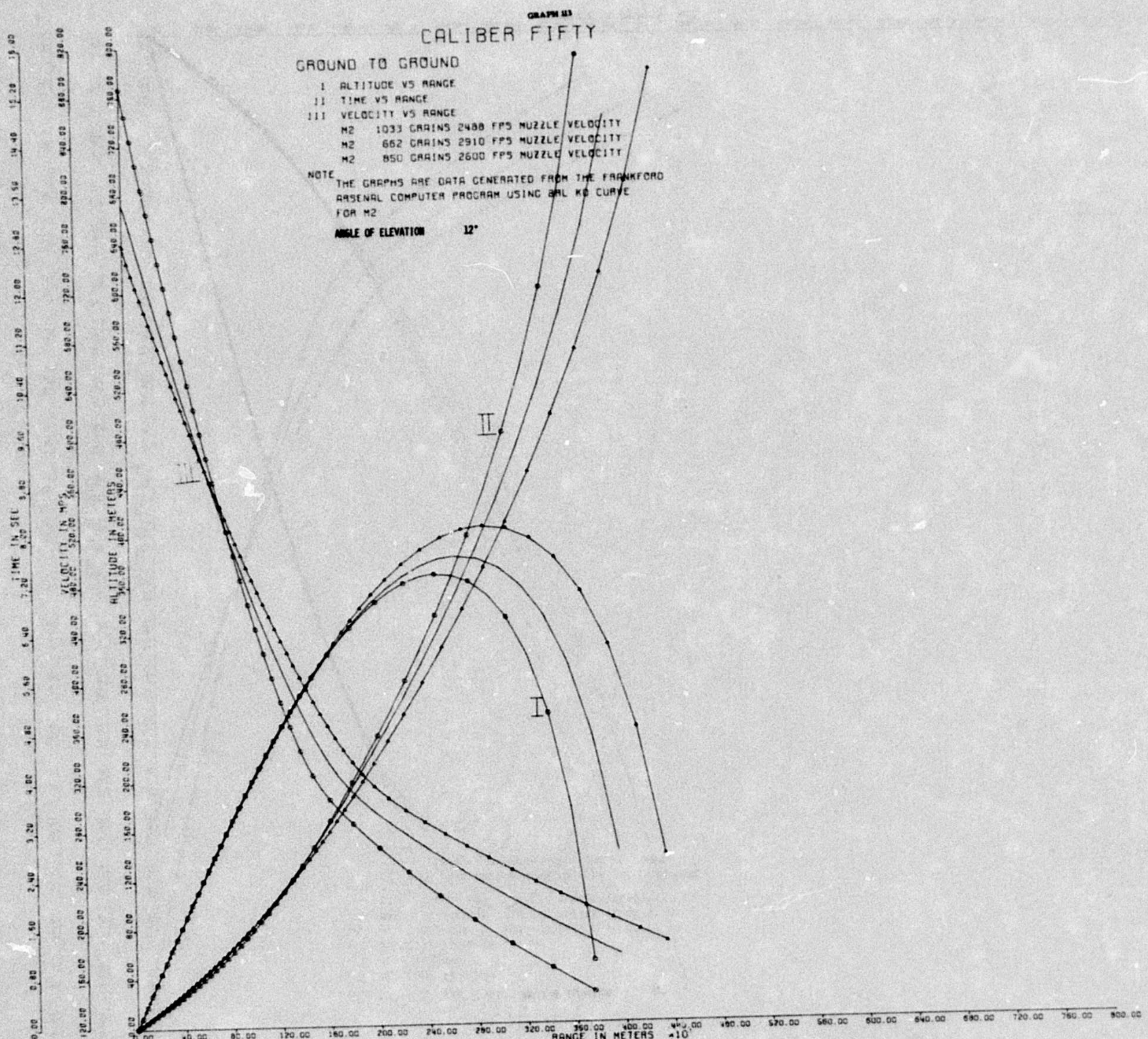

CALIBER FIFTY
GROUND TO GROUND
ALTITUDE VS RANGE
TIME VS RANGE
VELOCITY VS RANGE
I
II
III
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC
RANGE IN METERS

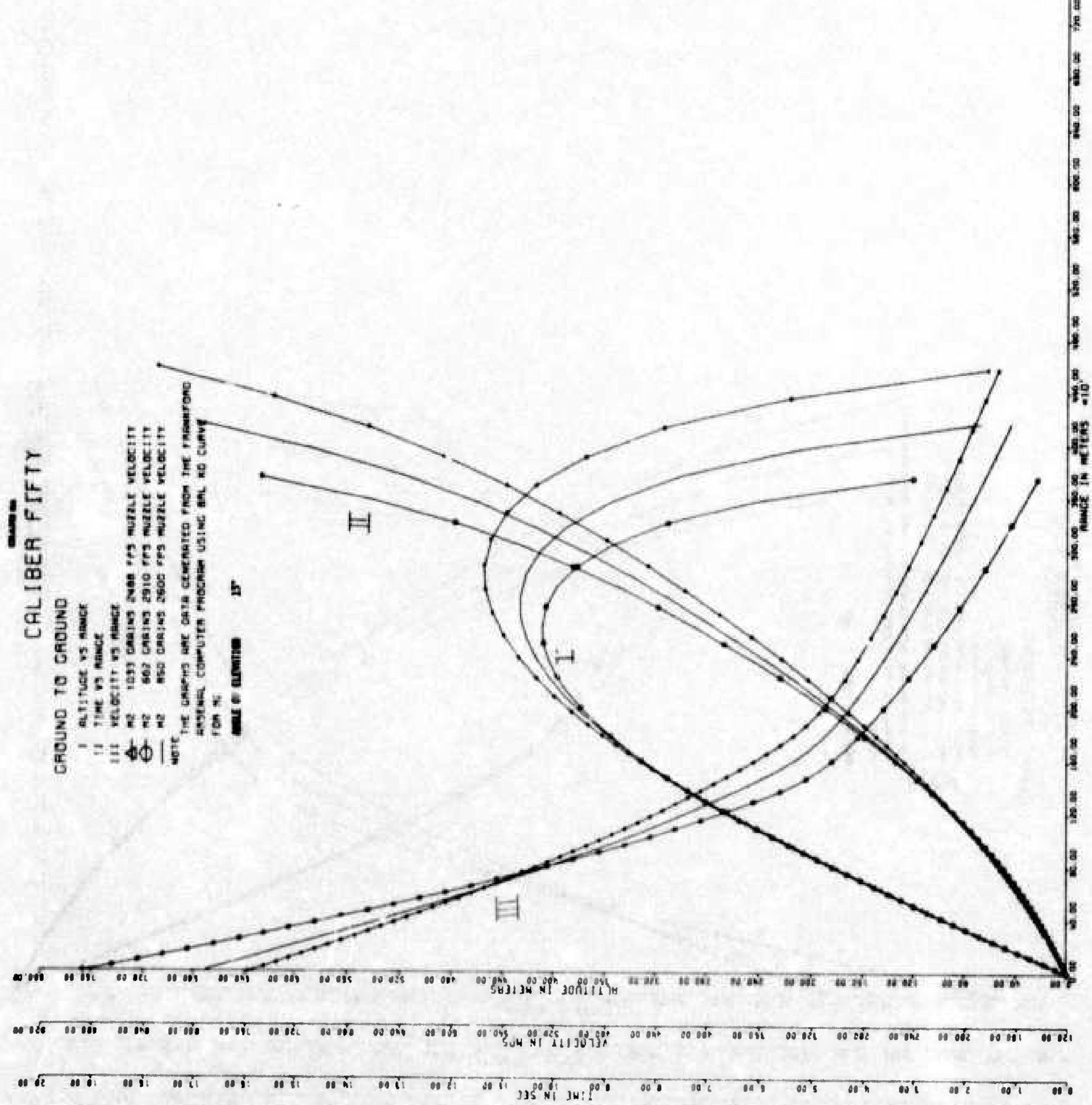

CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M2 1033 GRAINS 2488 FPS MUZZLE VELOCITY
M2 682 GRAINS 2910 FPS MUZZLE VELOCITY
M2 850 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M2
ANGLE OF ELEVATION
RANGE IN METERS *10
I
II
III

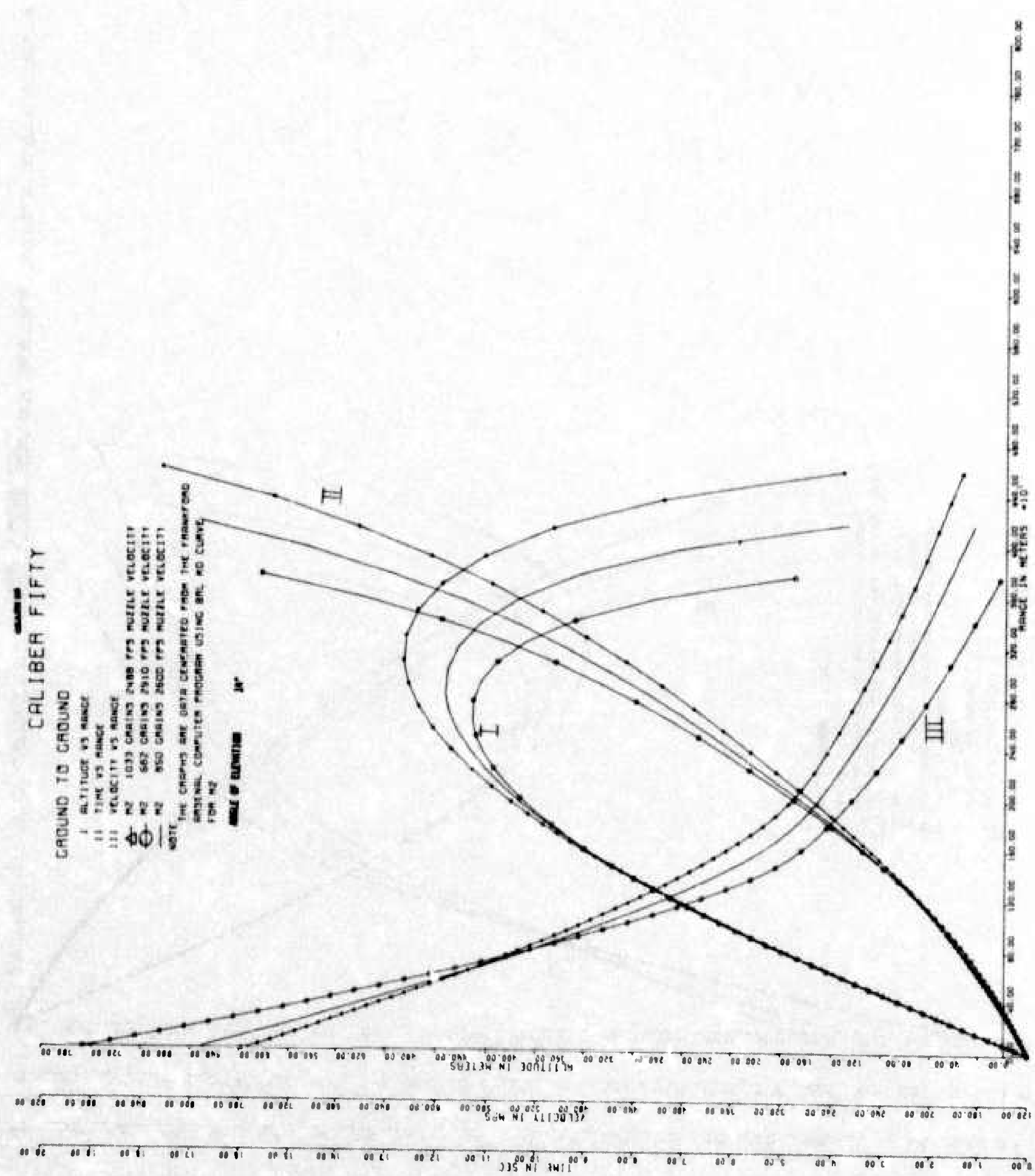

CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M2 1033 GRAINS 2495 FPS MUZZLE VELOCITY
M2 662 GRAINS 2910 FPS MUZZLE VELOCITY
M2 950 GRAINS 2800 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL TO CURVE
FOR M2
I
II
III
RANGE IN METERS ×10¹

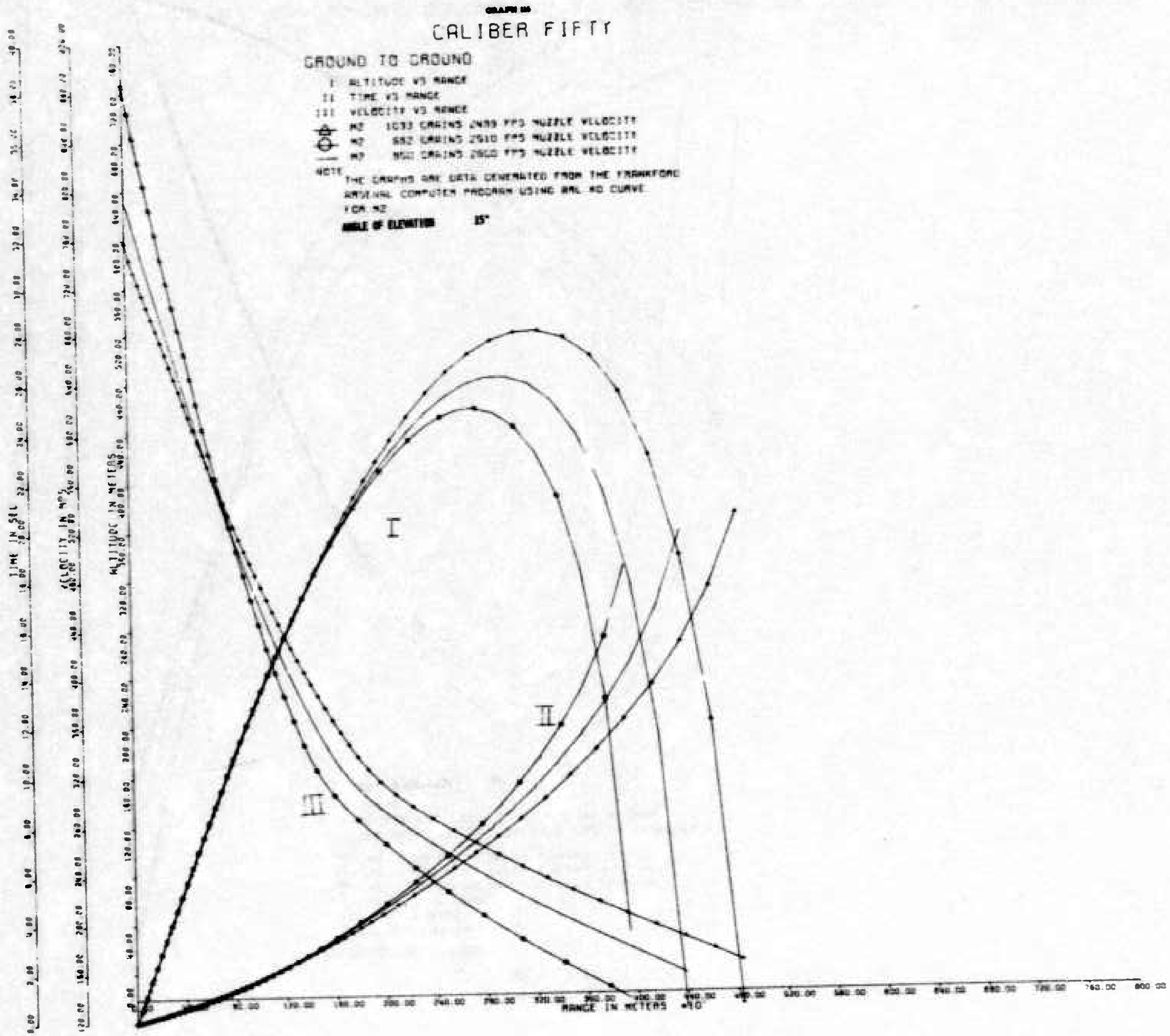

GRAPH III
CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M2 1033 GRAINS 2488 FPS MUZZLE VELOCITY
M2 662 GRAINS 2910 FPS MUZZLE VELOCITY
M2 850 GRAINS 2800 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BAL KD CURVE FOR M2
ANGLE OF ELEVATION 10°
I
II
III
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS *10

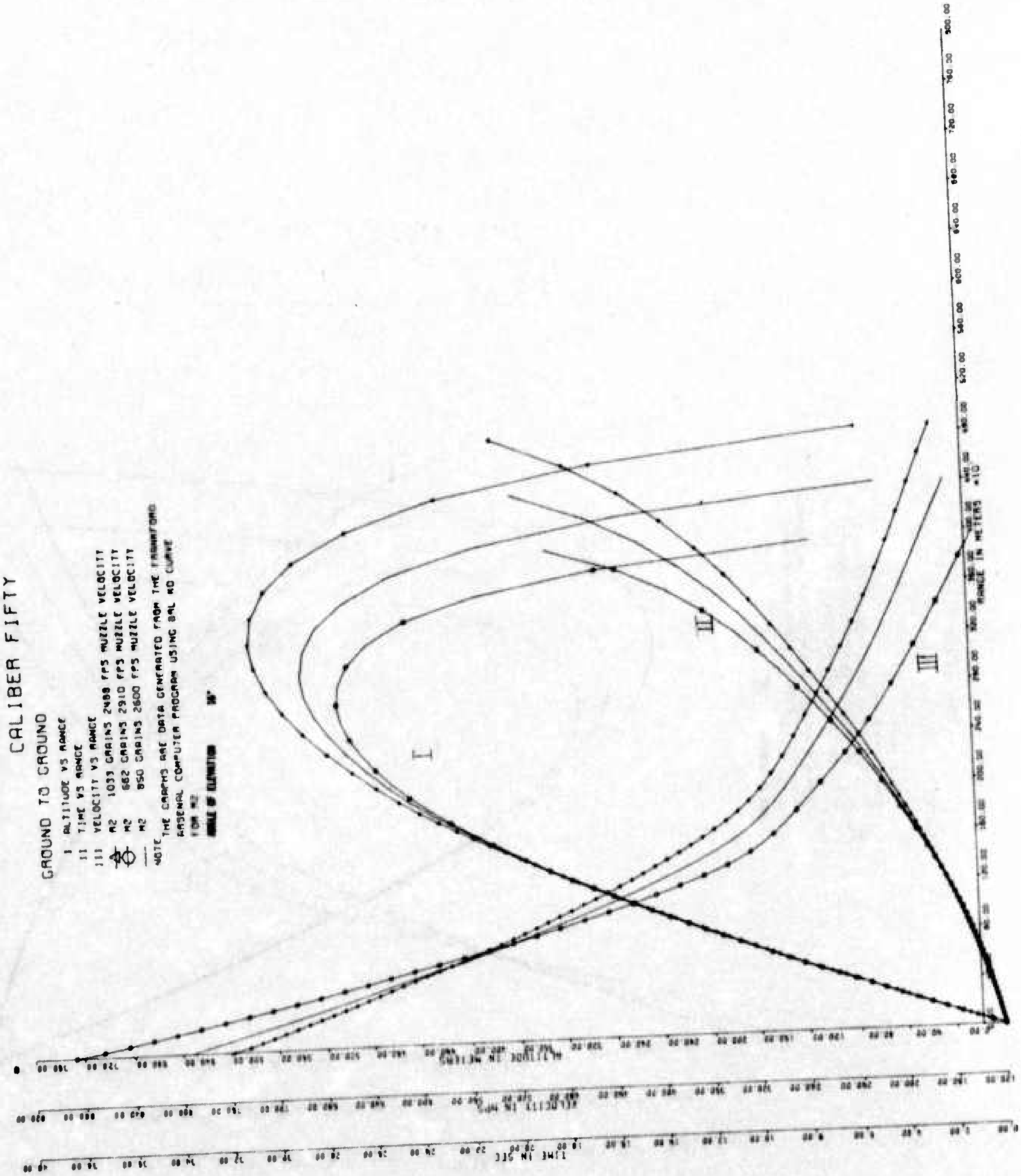

CALIBER FIFTY
GROUND TO GROUND
ANGLE OF ELEVATION 11°
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M2 1033 GRAINS 2488 FPS MUZZLE VELOCITY
M2 662 GRAINS 2910 FPS MUZZLE VELOCITY
M2 850 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BAL KD CURVE FOR M2
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS *10


GRAPH 113
CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M2 1033 GRAINS 2488 FPS MUZZLE VELOCITY
M2 662 GRAINS 2910 FPS MUZZLE VELOCITY
M2 850 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M2
ANGLE OF ELEVATION 12°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS ×10
I
II
III

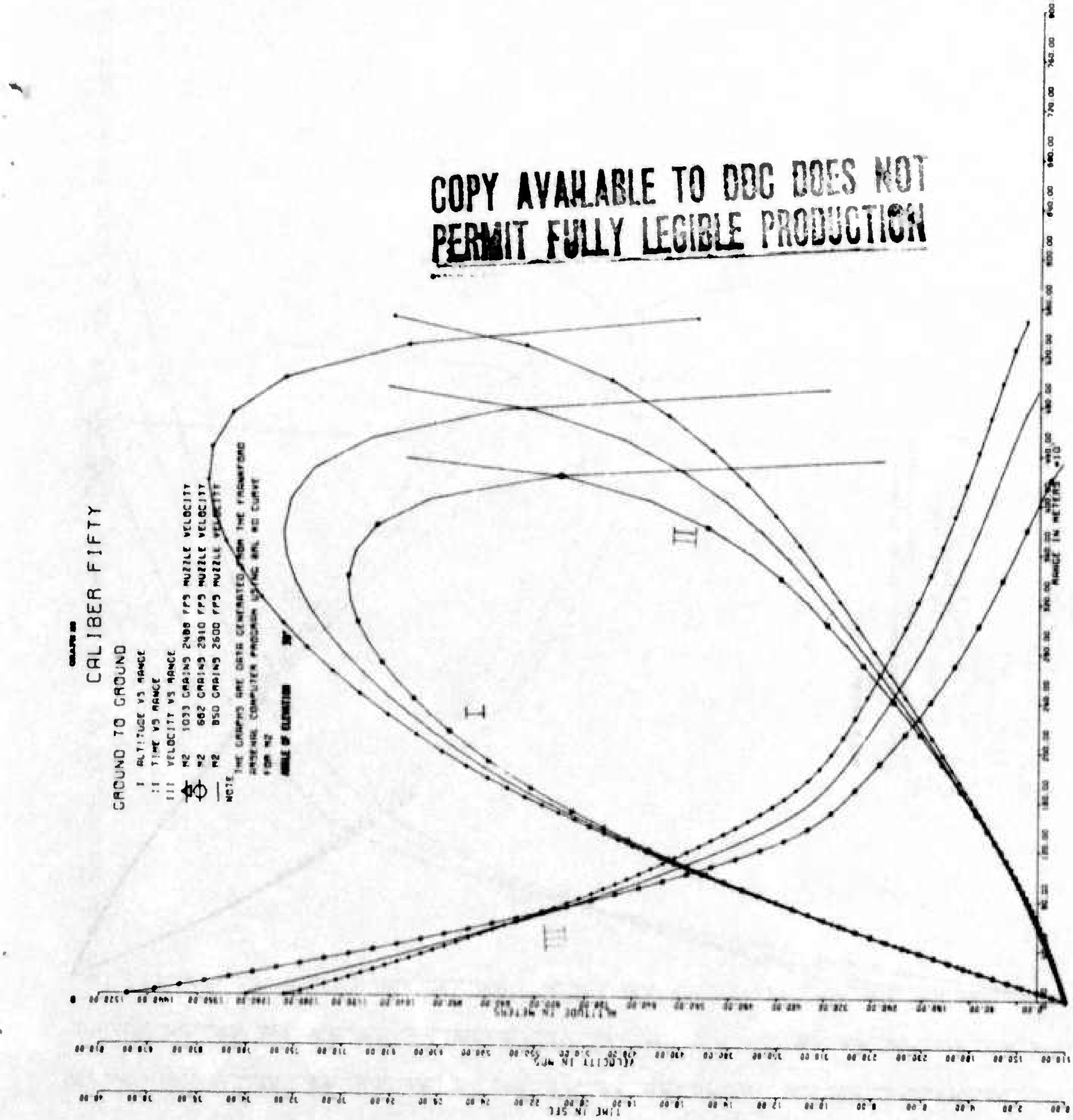

CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M2 1033 GRAINS 2808 FPS MUZZLE VELOCITY
M2 662 GRAINS 2910 FPS MUZZLE VELOCITY
M2 850 GRAINS 2800 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M2
ANGLE OF ELEVATION 15°
RANGE IN METERS *10
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC
I
II
III

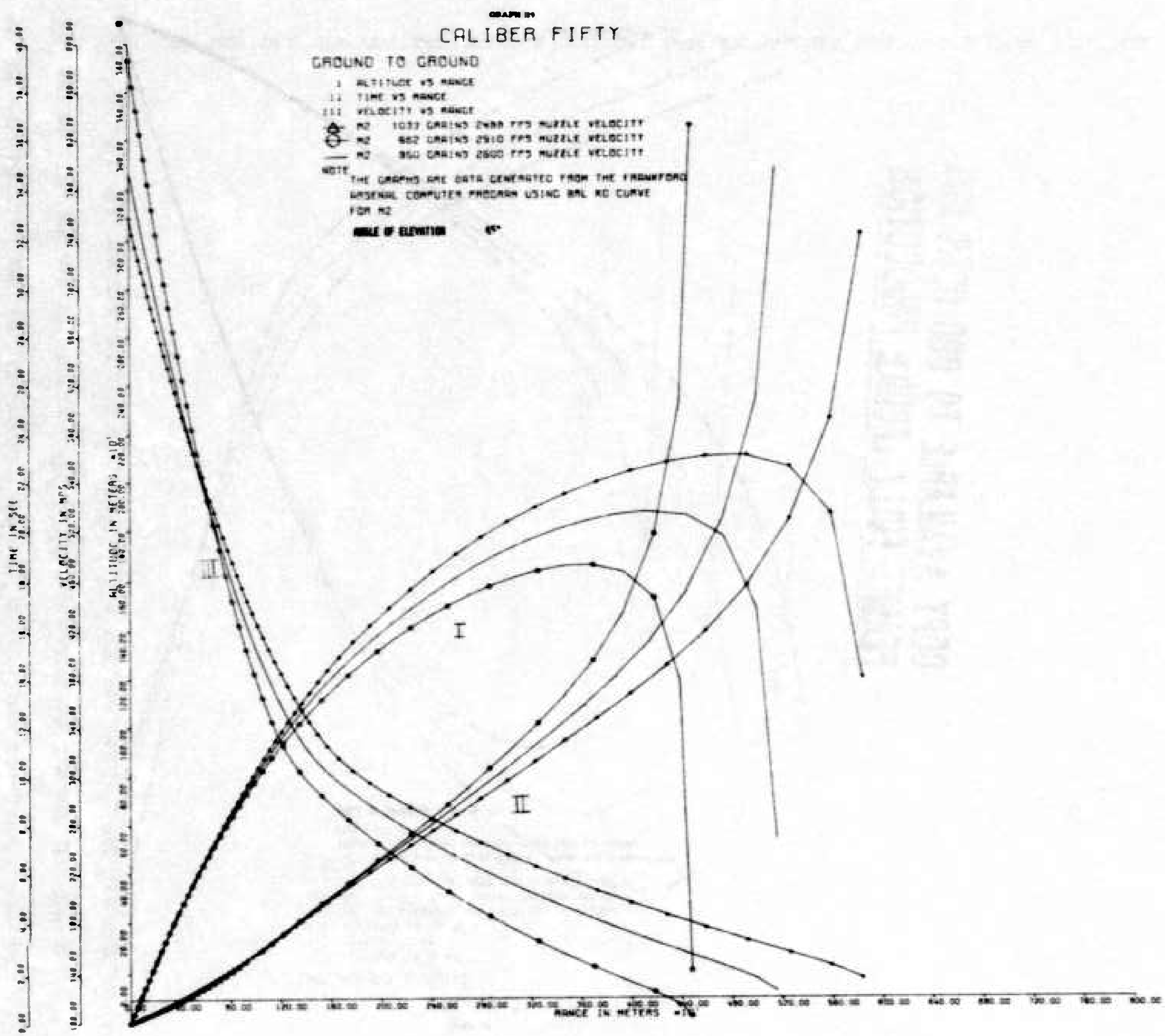

CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M2 1033 GRAINS 2488 FPS MUZZLE VELOCITY
M2 682 GRAINS 2910 FPS MUZZLE VELOCITY
M2 850 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M2
ANGLE OF ELEVATION
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS
I
II
III

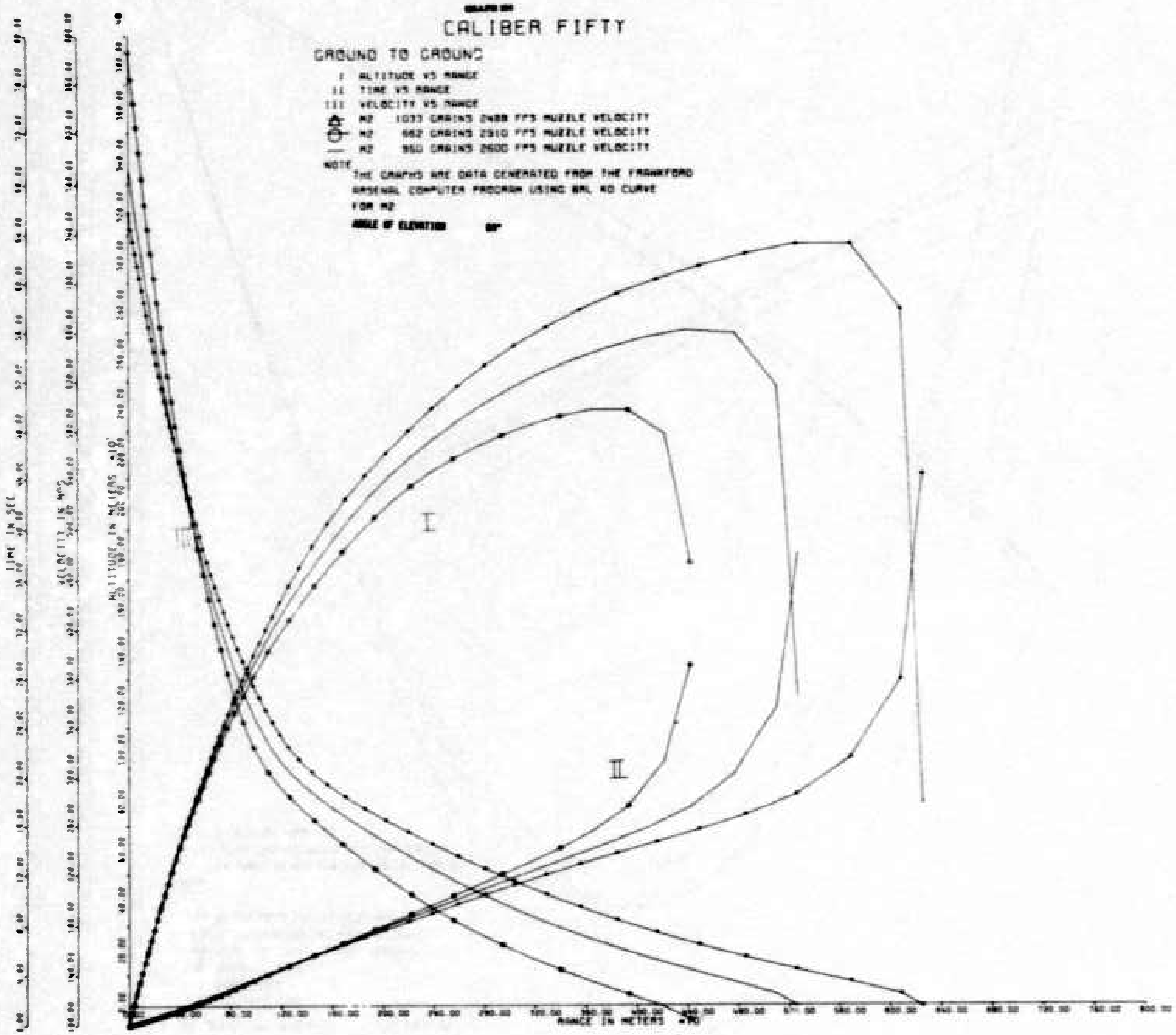

CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M2
M2
M2
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING
FOR M2
ANGLE OF ELEVATION 15°
I
II
III
RANGE IN METERS
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC

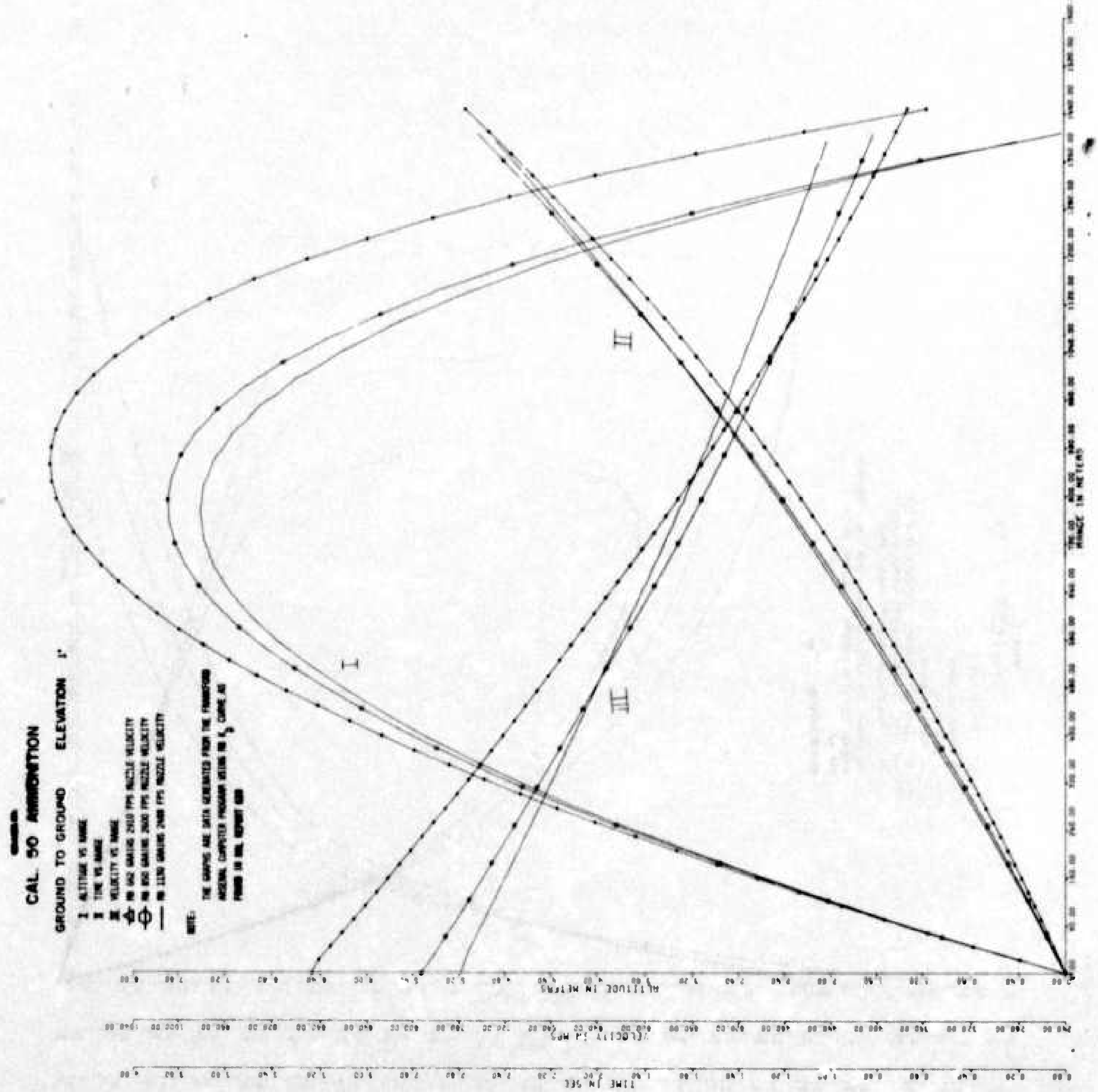


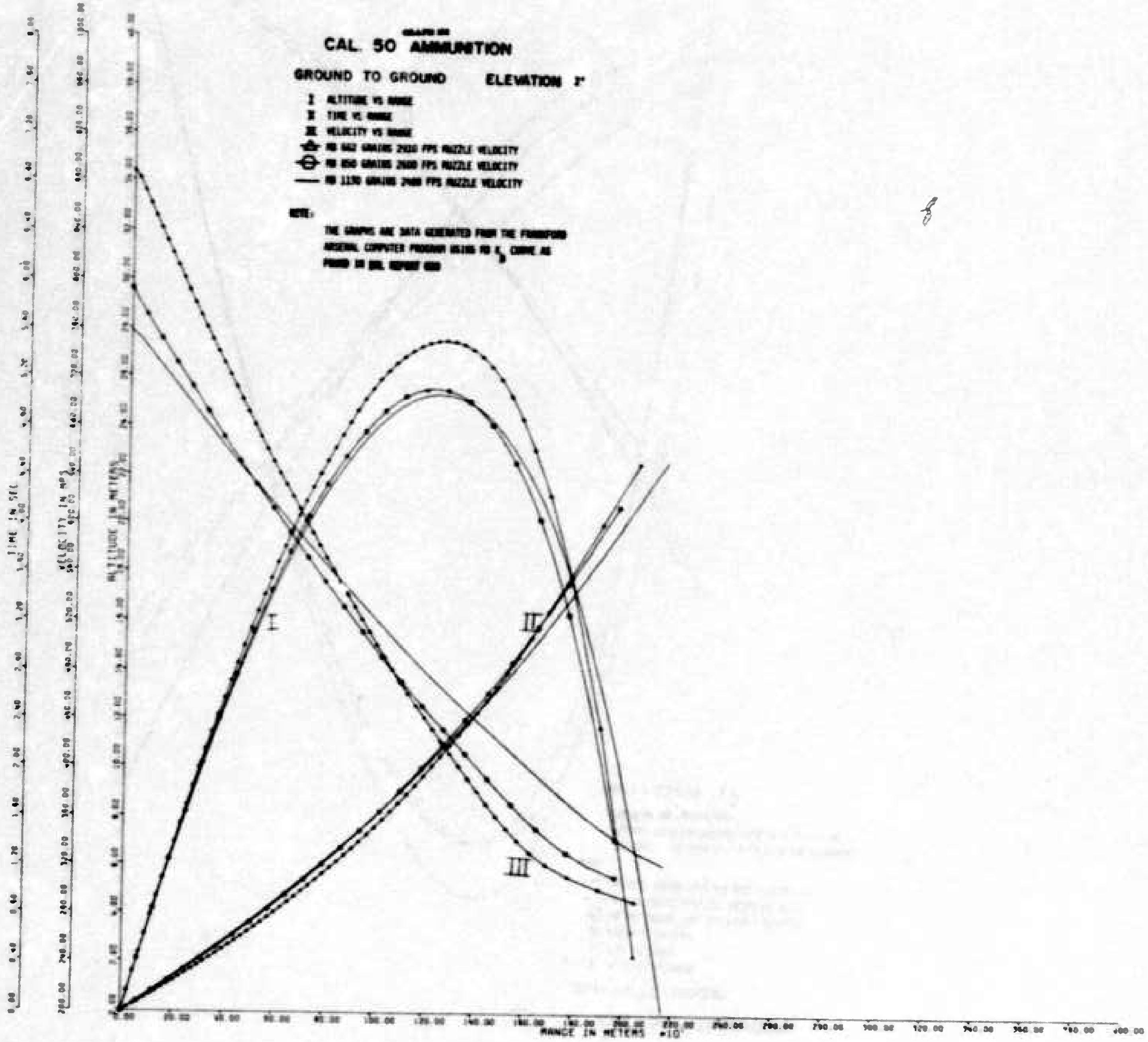
CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
A2 1033 GRAINS 2400 FPS MUZZLE VELOCITY
M2 662 GRAINS 2910 FPS MUZZLE VELOCITY
M2 850 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BAL KD CURVE
FOR M2
RANGE IN METERS x10
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC
I
II
III

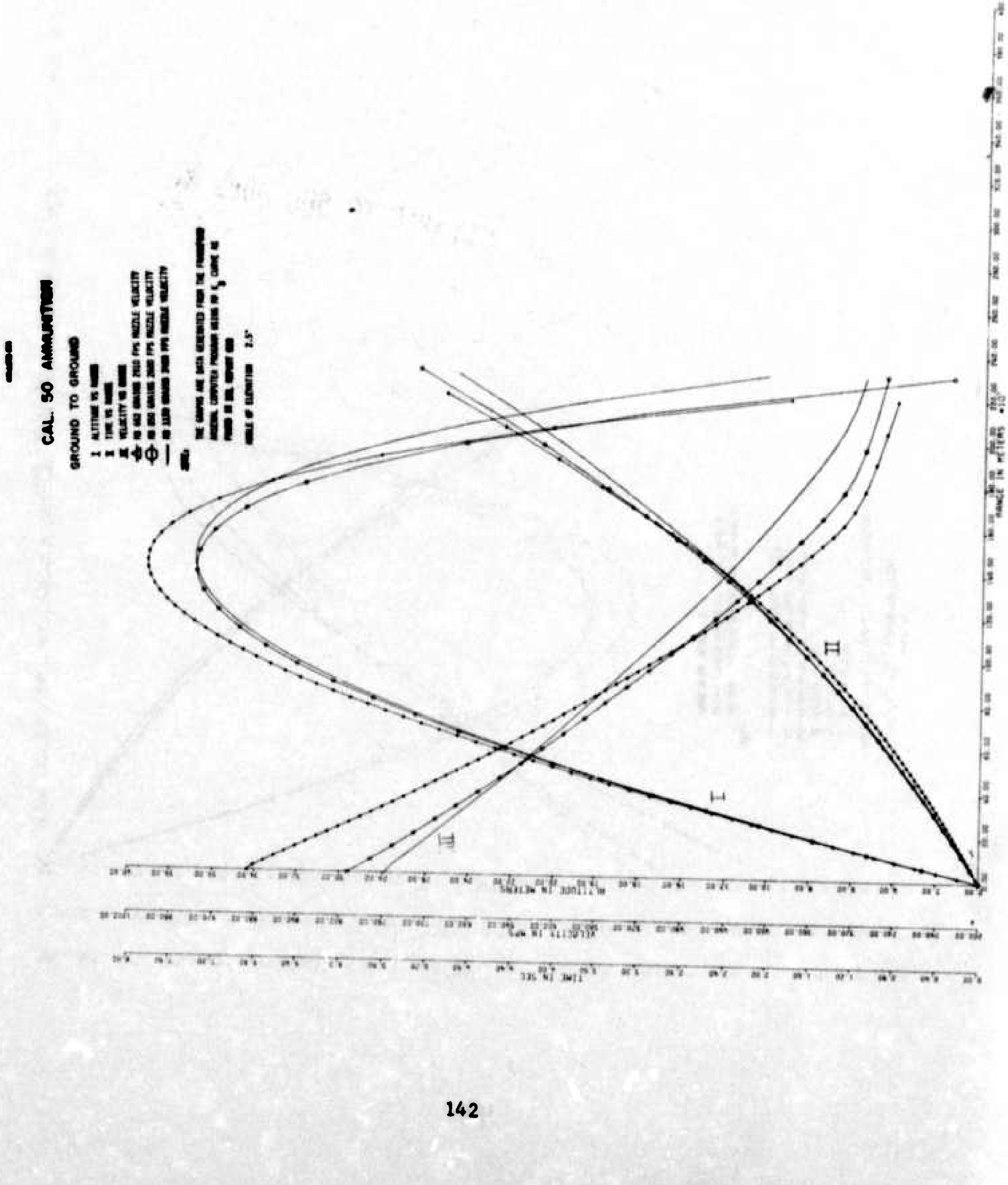

CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
I
II
III

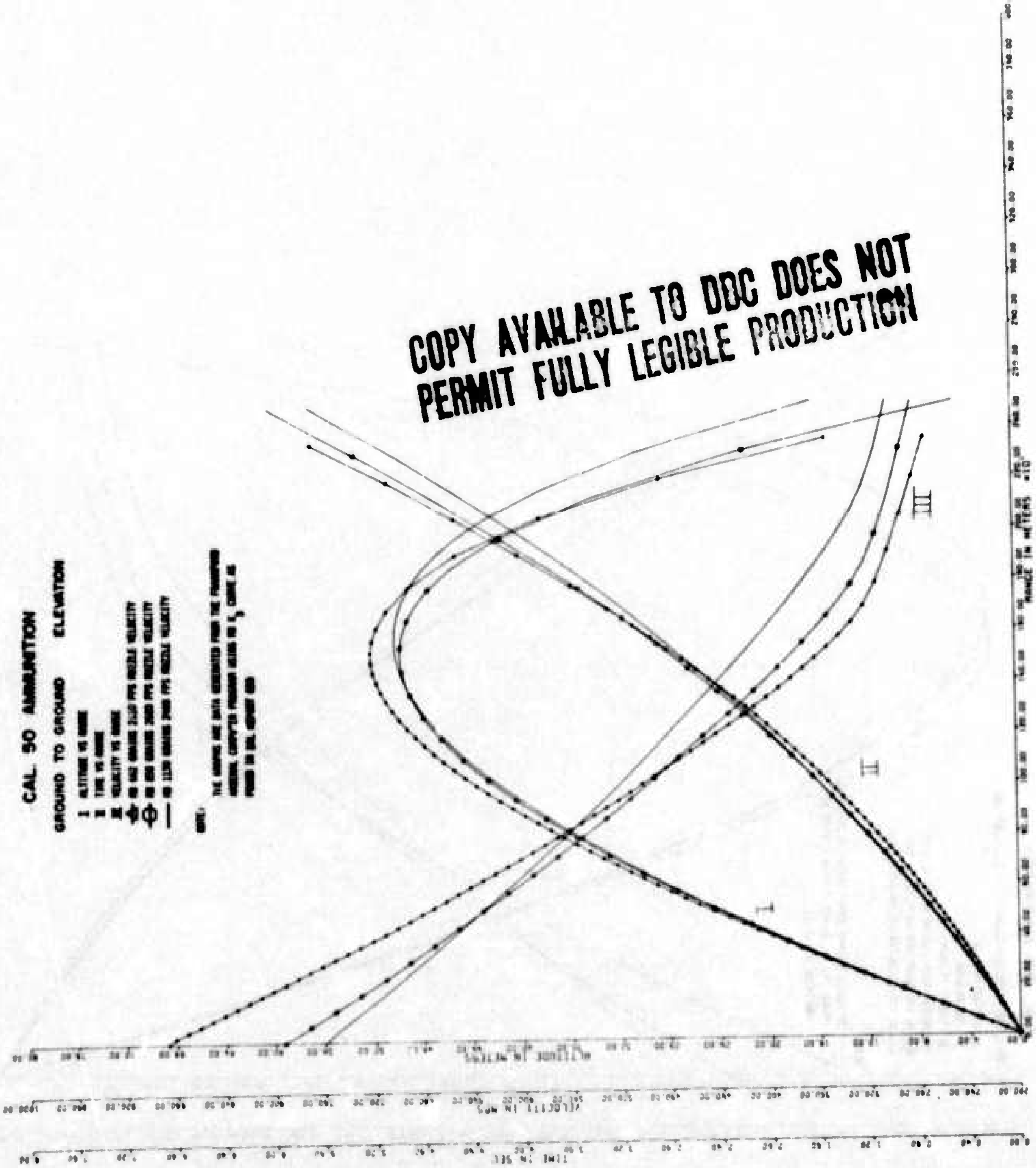

CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M2 1033 GRAINS 2480 FPS MUZZLE VELOCITY
M2 662 GRAINS 2910 FPS MUZZLE VELOCITY
M2 850 GRAINS 2800 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M2
ANGLE OF ELEVATION
I
II
III
RANGE IN METERS
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC

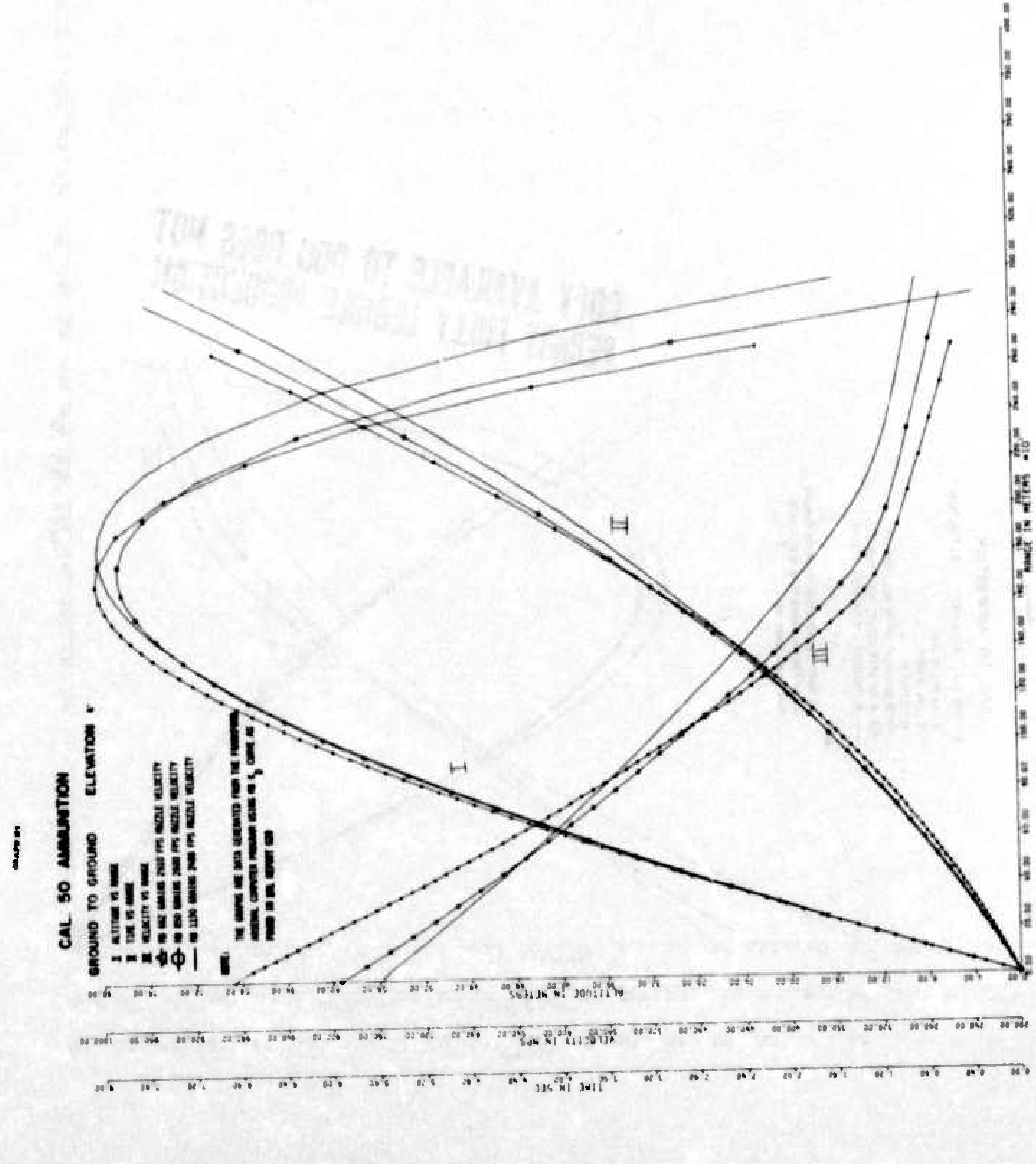

CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M2 1033 GRAINS 2488 FPS MUZZLE VELOCITY
M2 662 GRAINS 2910 FPS MUZZLE VELOCITY
M2 950 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD
ARSENAL COMPUTER PROGRAM USING BRL KD CURVE
FOR M2
ANGLE OF ELEVATION
I
II
III
RANGE IN METERS
ALTITUDE IN METERS
VELOCITY IN M/S
TIME IN SEC


CAL. 50 AMMUNITION
GROUND TO GROUND ELEVATION 1°
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC
RANGE IN METERS
I
II
III


CAL. 50 AMMUNITION
GROUND TO GROUND ELEVATION
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
NOTE:
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS ×10
I
II
III


CAL. 50 AMMUNITION
GROUND TO GROUND
I
II
III
RANGE IN METERS ×10
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC


CAL. 50 AMMUNITION
GROUND TO GROUND ELEVATION


CAL. 50 AMMUNITION
GROUND TO GROUND
ELEVATION
ALTITUDE VS RANGE
TIME VS RANGE
VELOCITY VS RANGE
I
II
III
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC
RANGE IN METERS

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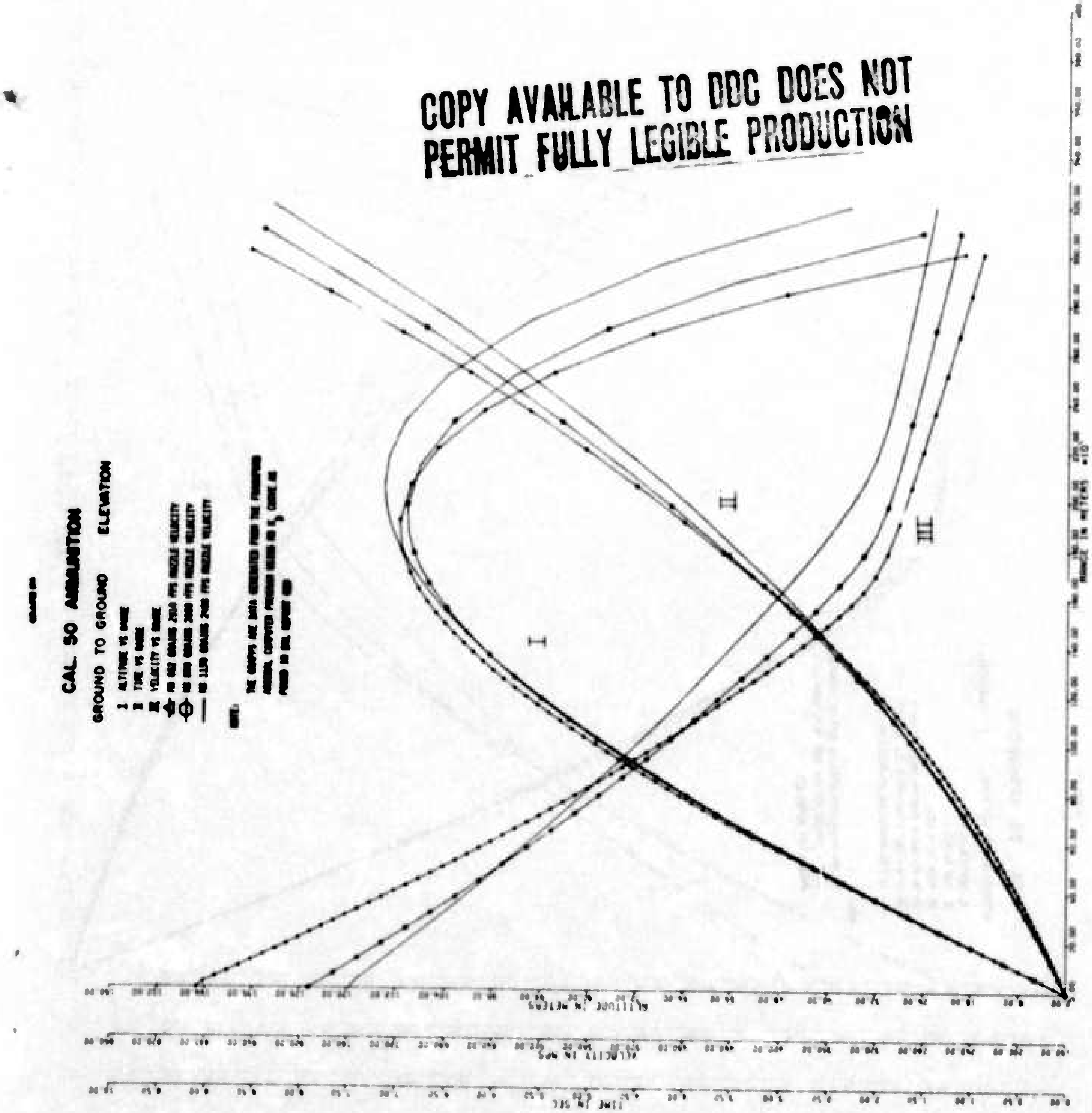
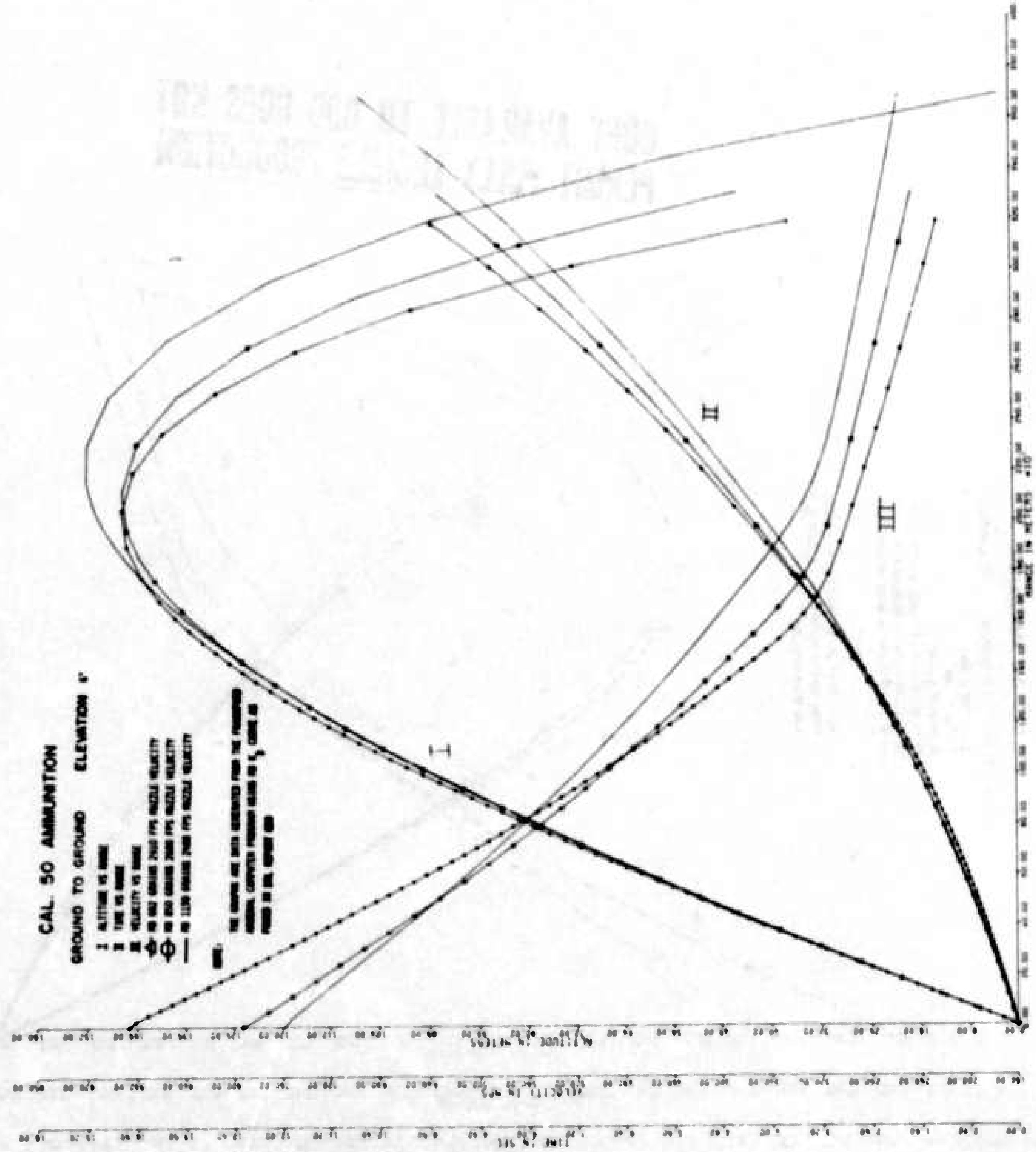
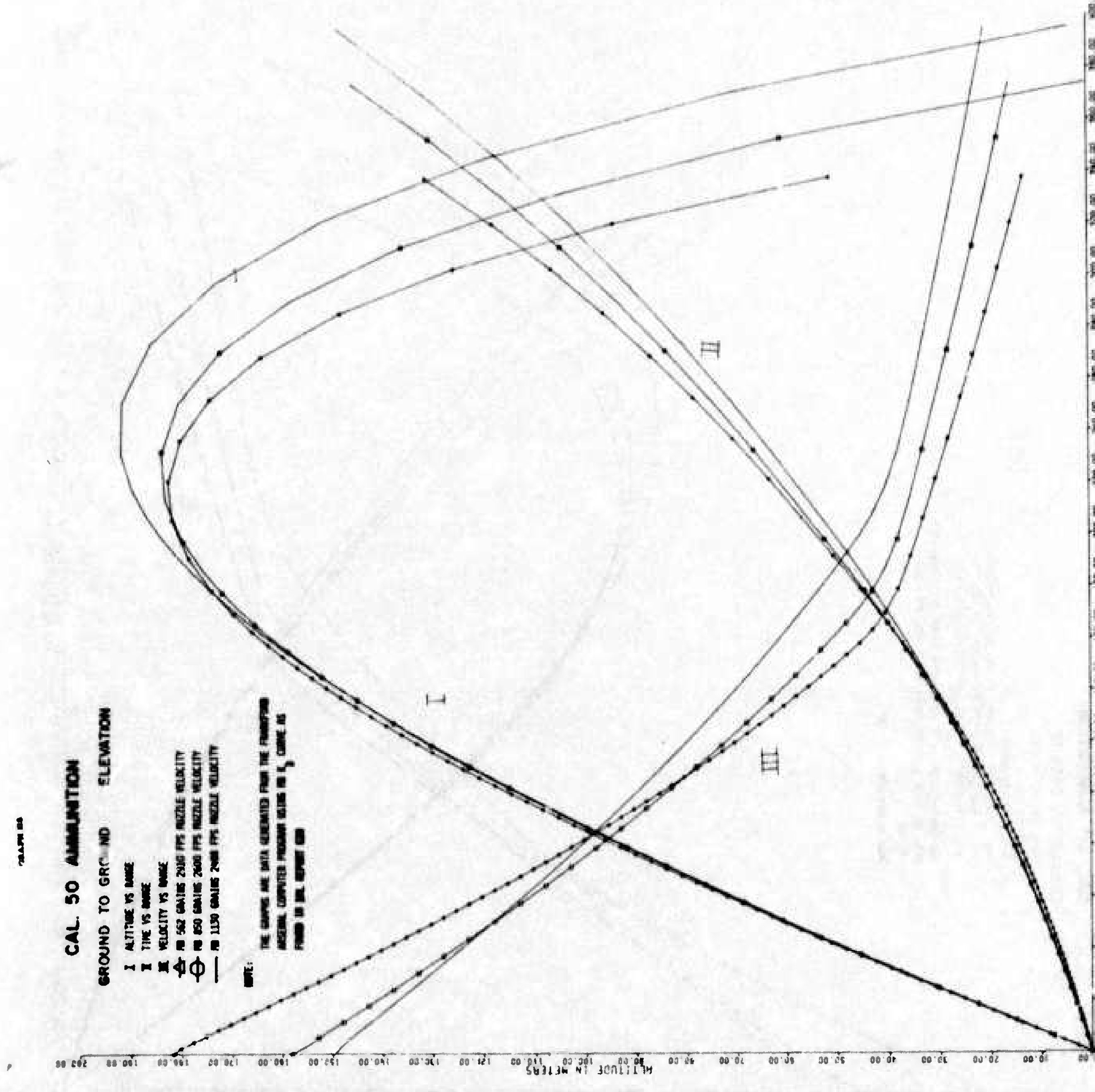
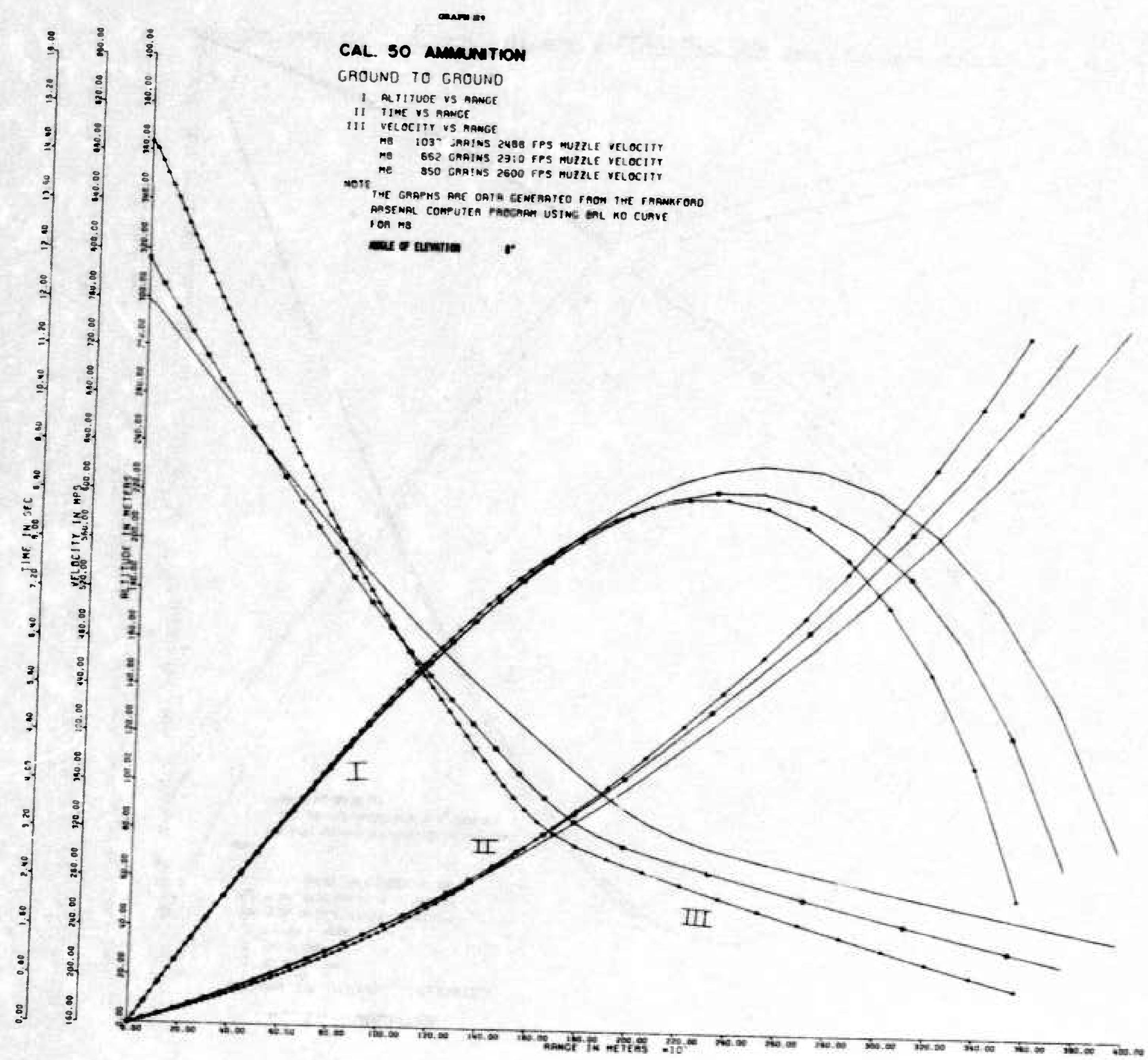



CAL. 50 AMMUNITION
GROUND TO GROUND
ELEVATION
I
II
III


CAL. 50 AMMUNITION
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC
RANGE IN METERS
I
II
III



GRAPH 29
CAL. 50 AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M8 1037 GRAINS 2488 FPS MUZZLE VELOCITY
M8 662 GRAINS 2910 FPS MUZZLE VELOCITY
M8 850 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M8
ANGLE OF ELEVATION 8°
I
II
III
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS *10

GRAPH 130

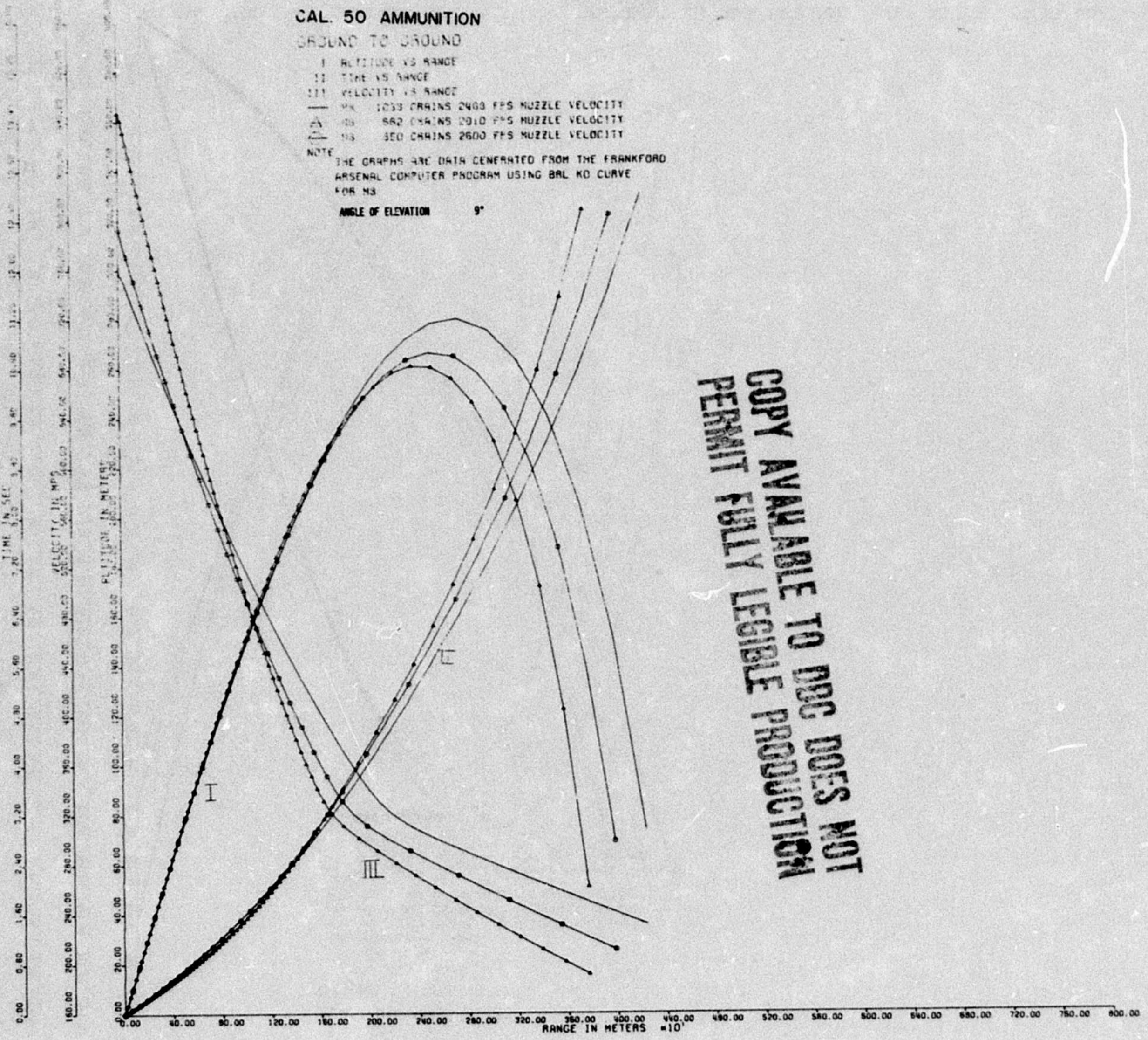
CAL. 50 AMMUNITION

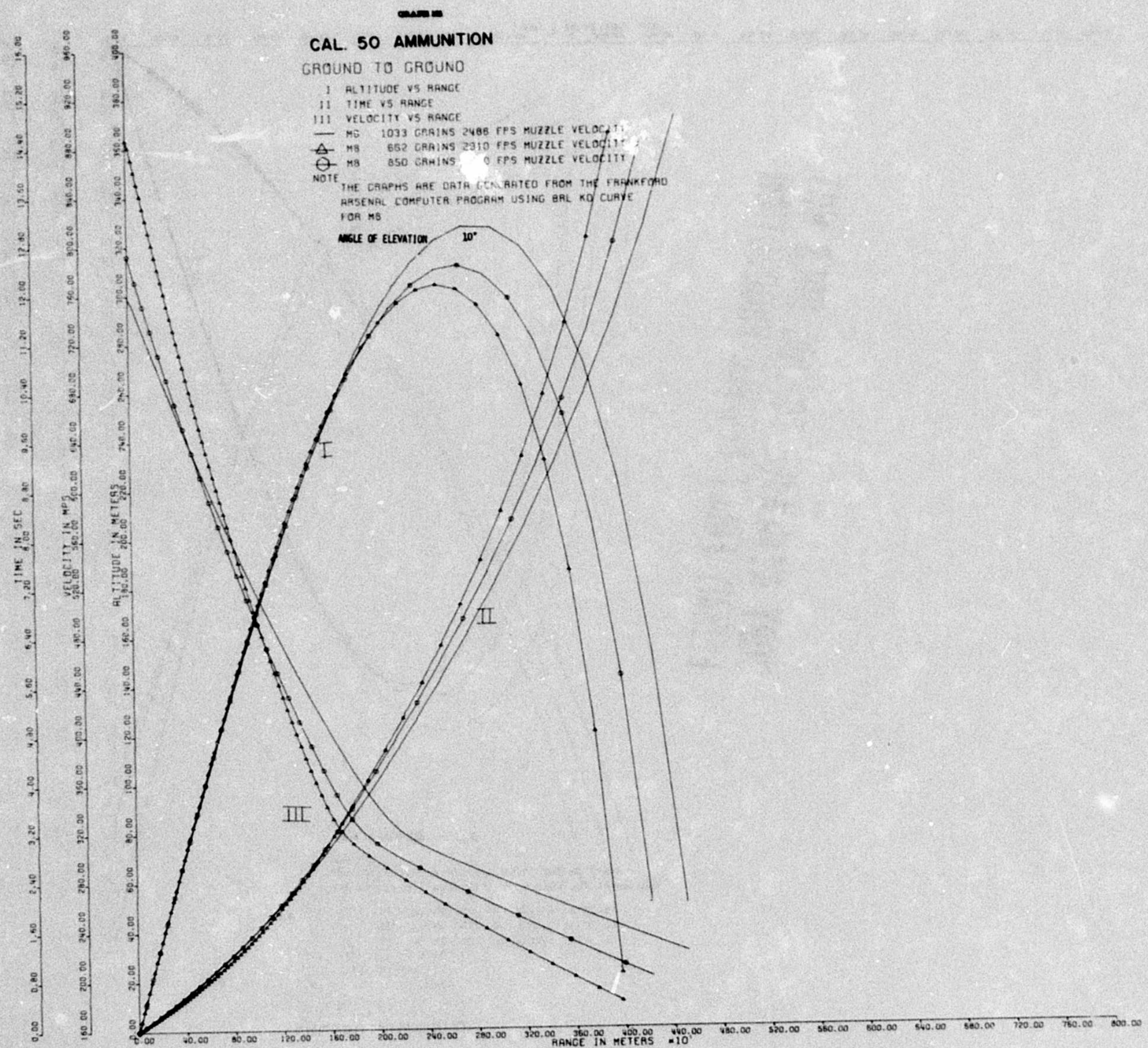
GROUND TO GROUND

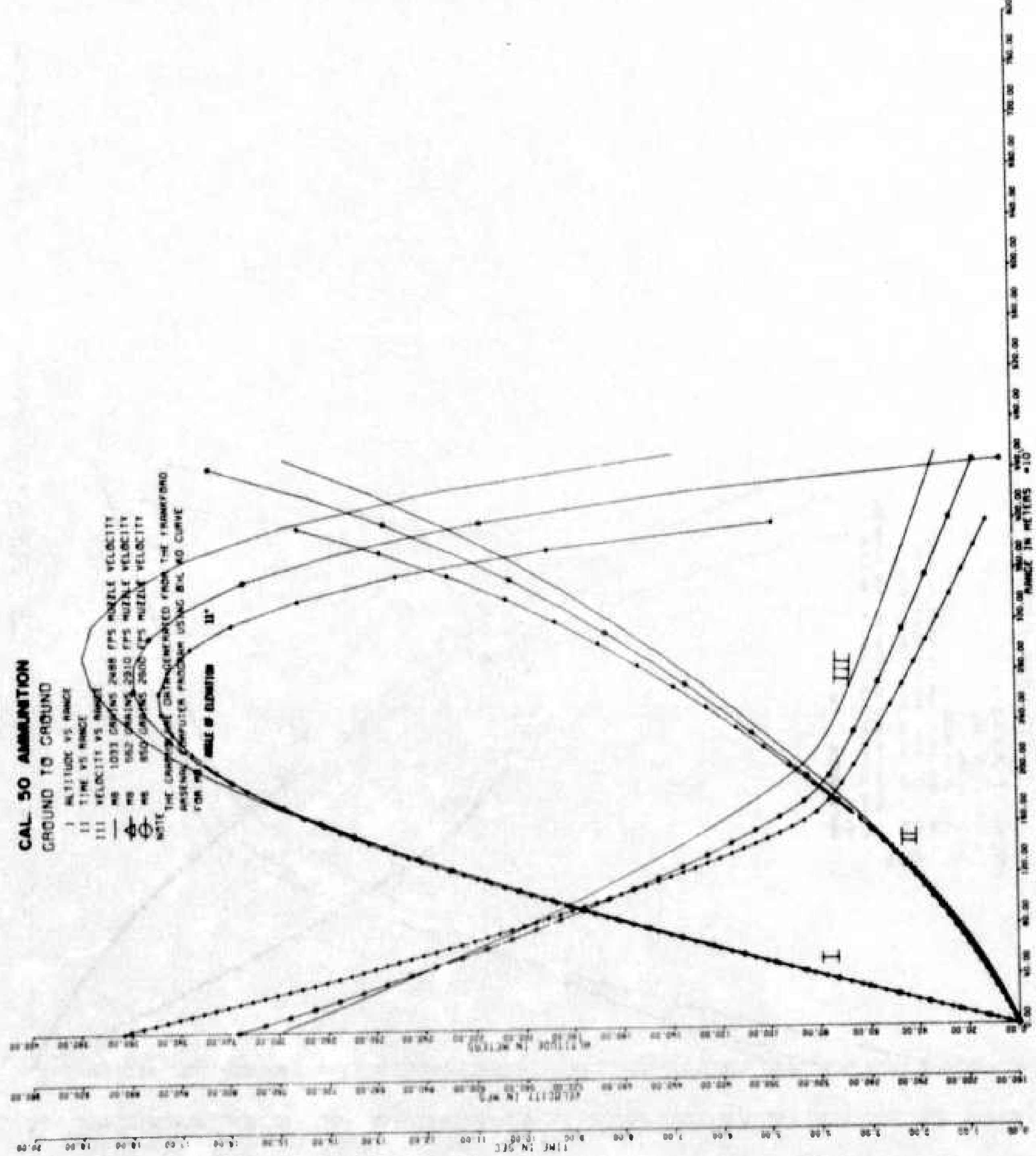
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
—— [illegible] 1033 GRAINS 2400 FPS MUZZLE VELOCITY
[illegible] 662 GRAINS 2910 FPS MUZZLE VELOCITY
[illegible] 350 GRAINS 2600 FPS MUZZLE VELOCITY

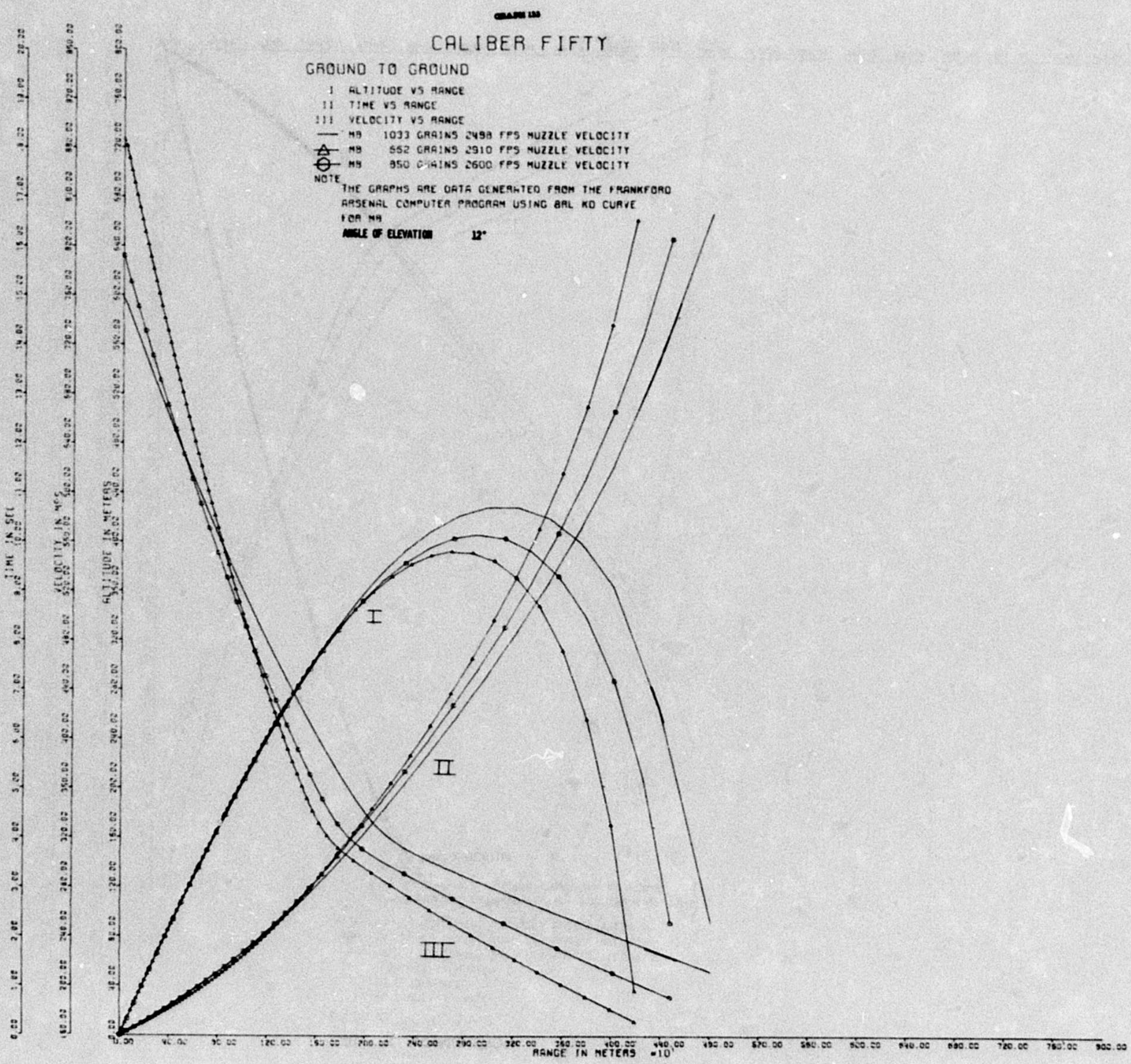
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR [illegible]

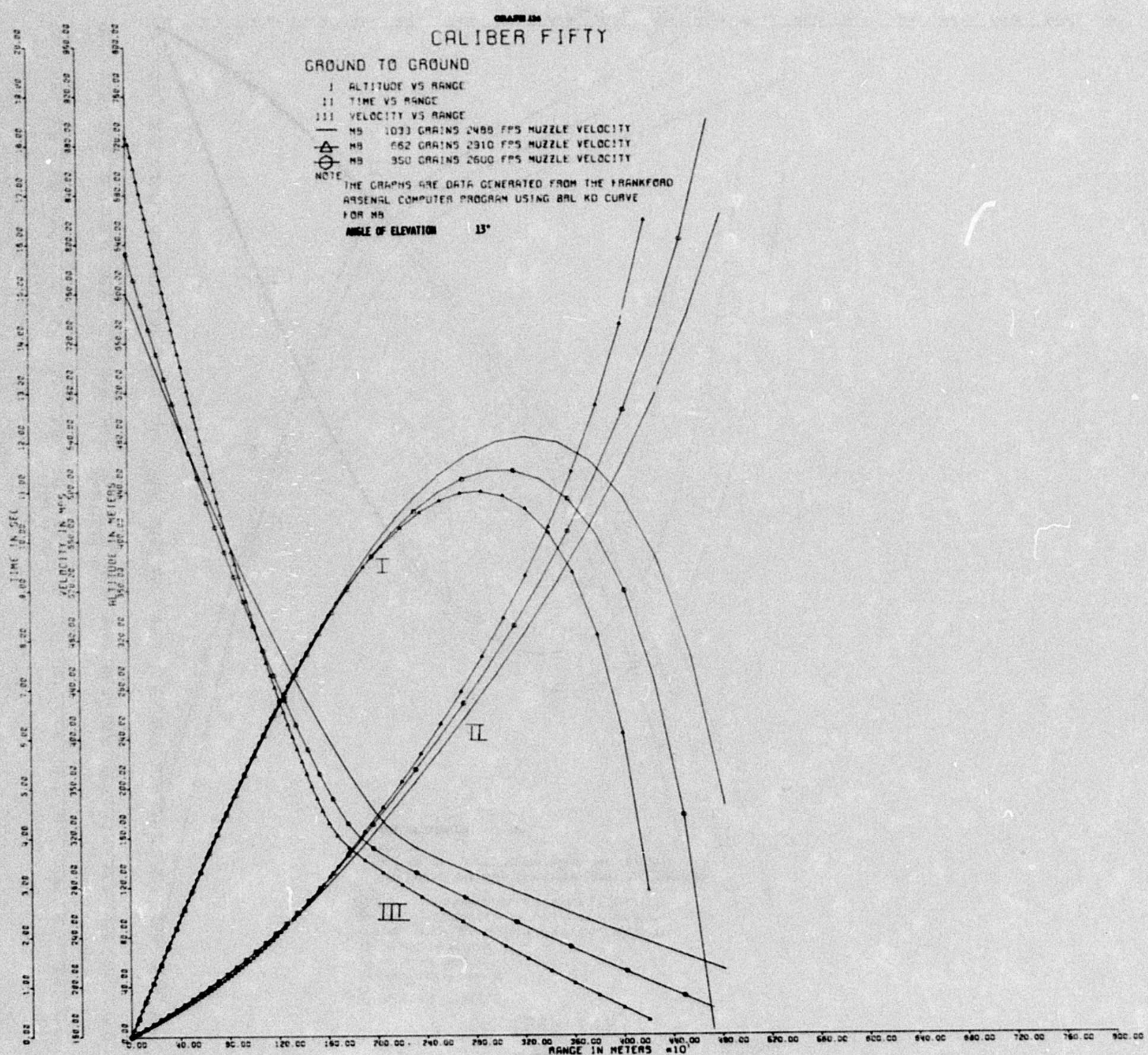
ANGLE OF ELEVATION 9°

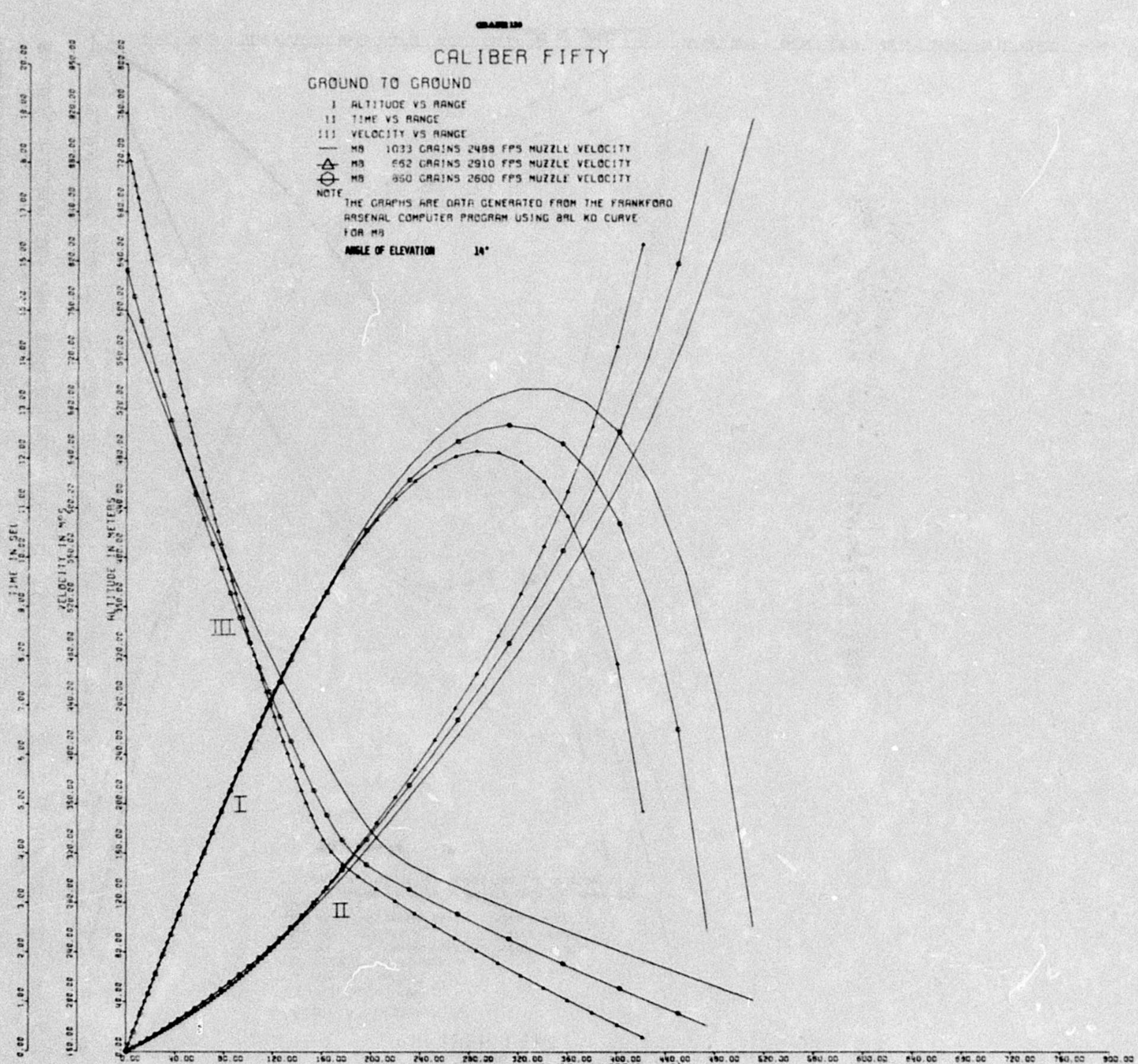



CAL. 50 AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M2 1033 GRAINS 2486 FPS MUZZLE VELOCITY
M8 662 GRAINS 2310 FPS MUZZLE VELOCITY
M8 850 GRAINS MUZZLE VELOCITY
NOTE THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M8
ANGLE OF ELEVATION 10°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS *10'
I
II
III

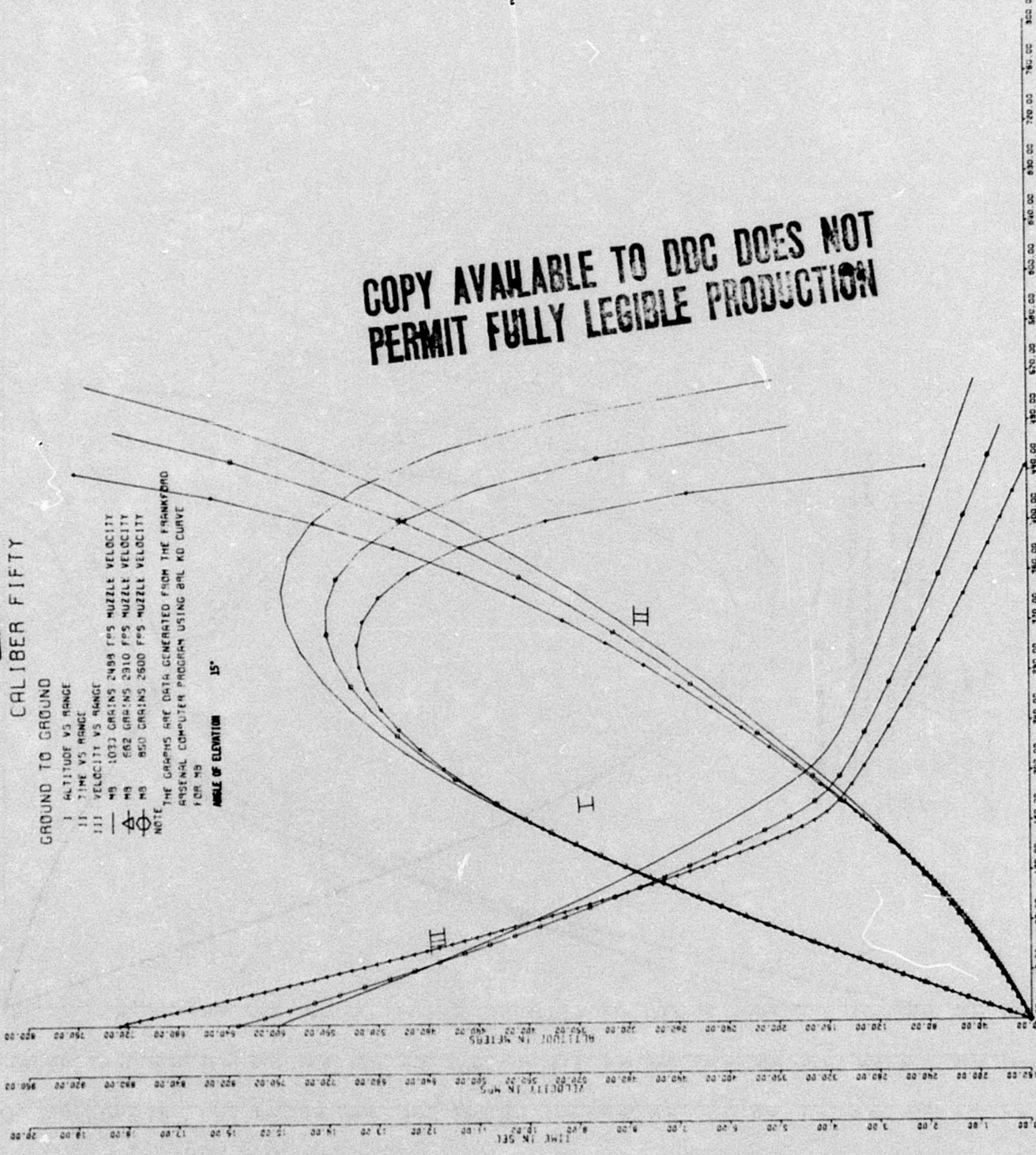

CAL. 50 AMMUNITION
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
NOTE
ANGLE OF ELEVATION
I
II
III
RANGE IN METERS
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS


CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M8 1033 GRAINS 2498 FPS MUZZLE VELOCITY
M8 662 GRAINS 2910 FPS MUZZLE VELOCITY
M8 850 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M8
ANGLE OF ELEVATION 12°
I
II
III
TIME IN SEC
VELOCITY IN M/S
ALTITUDE IN METERS
RANGE IN METERS *10¹


CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M8 1033 GRAINS 2488 FPS MUZZLE VELOCITY
M8 662 GRAINS 2910 FPS MUZZLE VELOCITY
M8 950 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M8
ANGLE OF ELEVATION 13°
I
II
III
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS

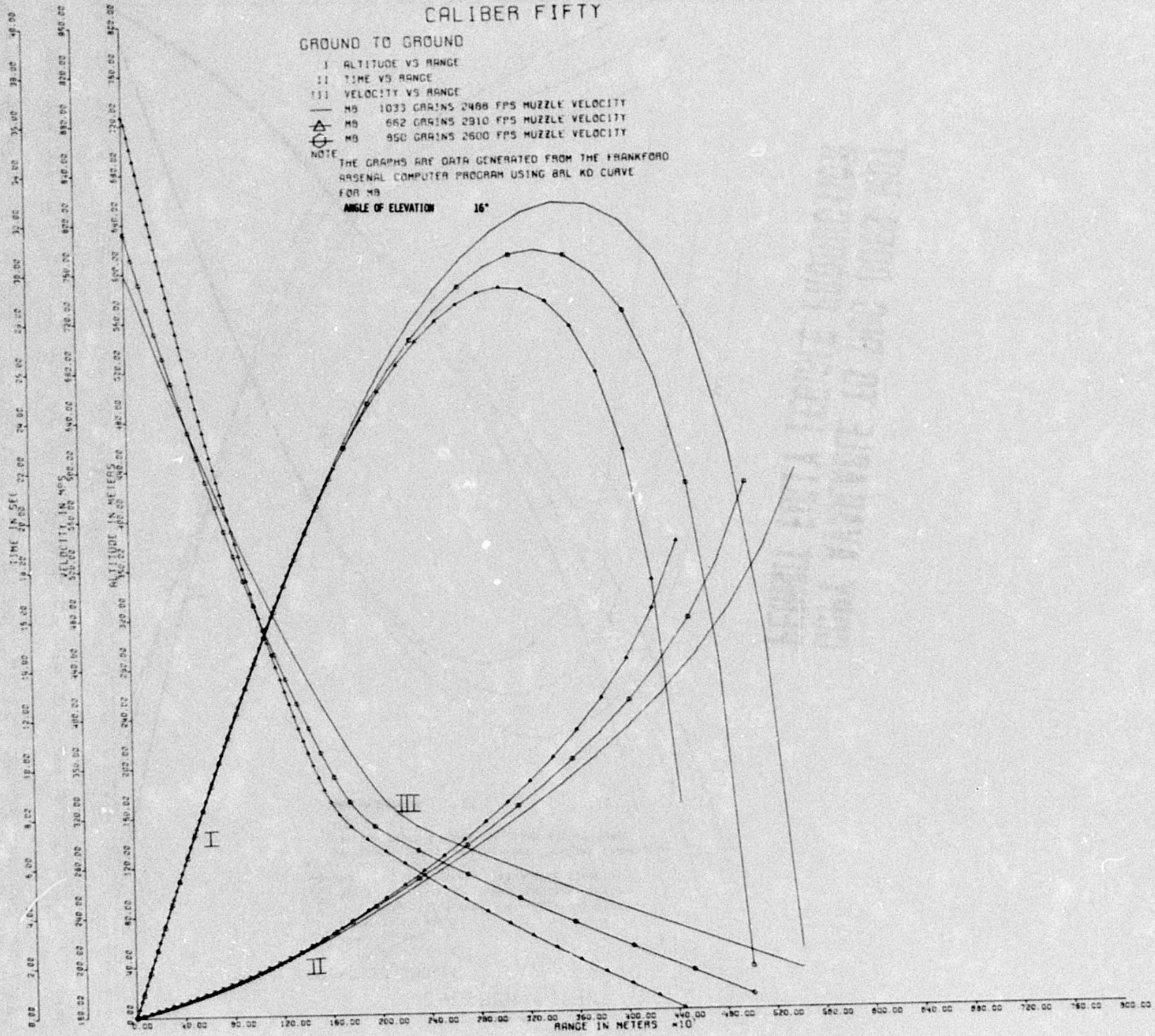


CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M8 1033 GRAINS 2488 FPS MUZZLE VELOCITY
M8 662 GRAINS 2910 FPS MUZZLE VELOCITY
M8 860 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M8
ANGLE OF ELEVATION 14°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS ×10
I
II
III

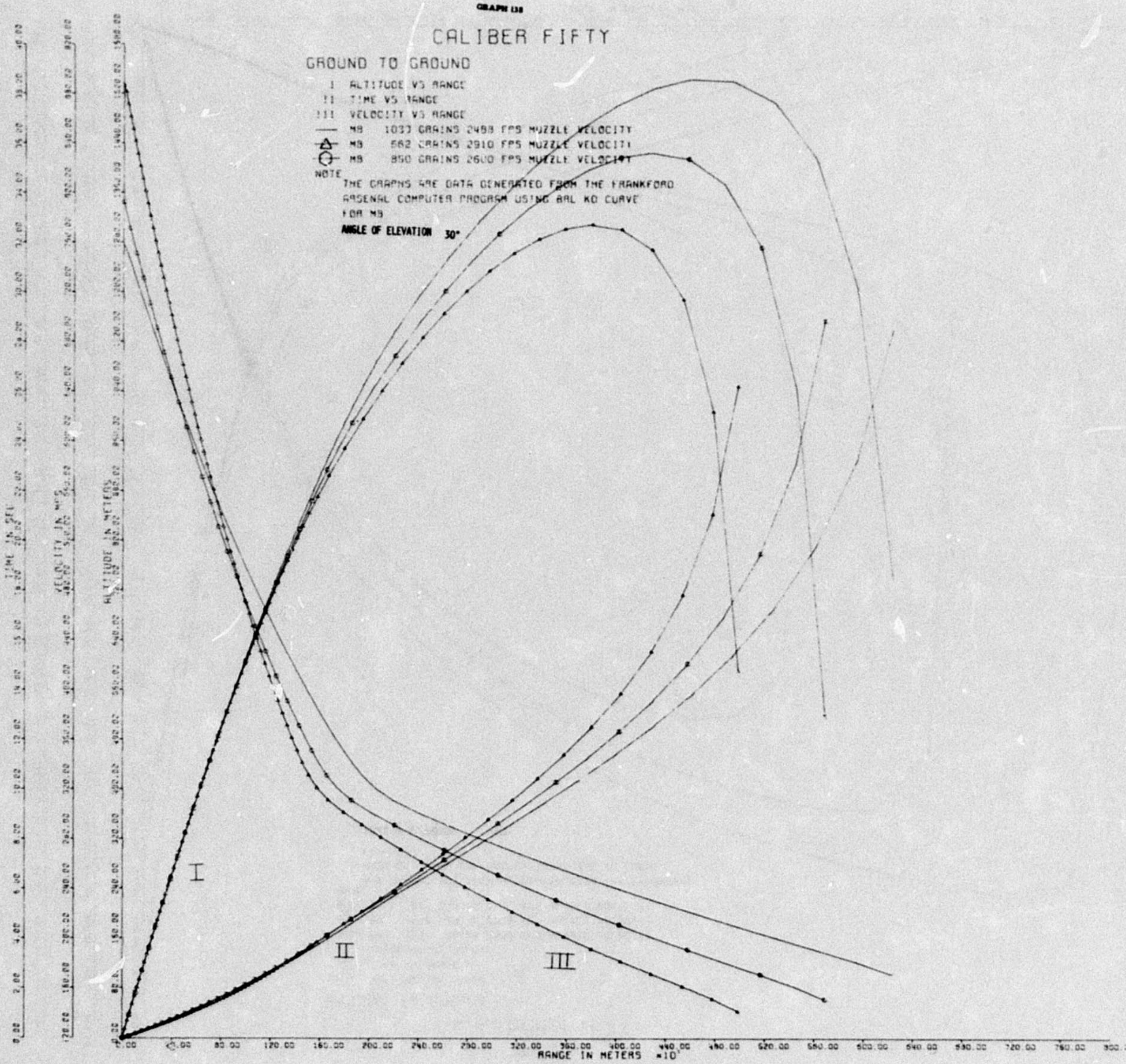


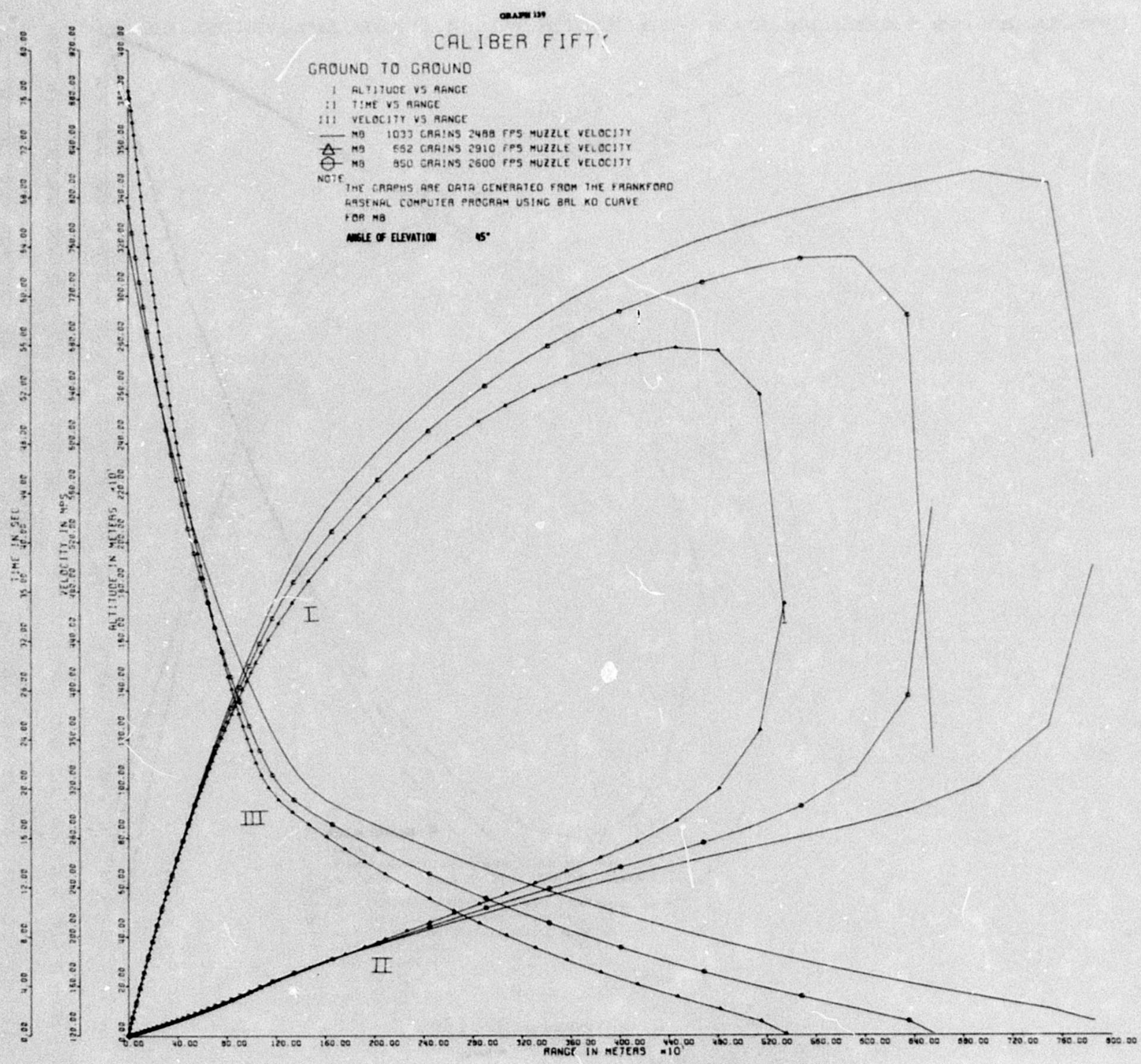
CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M8 1033 GRAINS 2498 FPS MUZZLE VELOCITY
M8 662 GRAINS 2910 FPS MUZZLE VELOCITY
M8 850 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BRL KD CURVE FOR M8
ANGLE OF ELEVATION 15°
I
II
III
RANGE IN METERS ×10
ALTITUDE IN METERS
VELOCITY IN MPS
TIME IN SEC

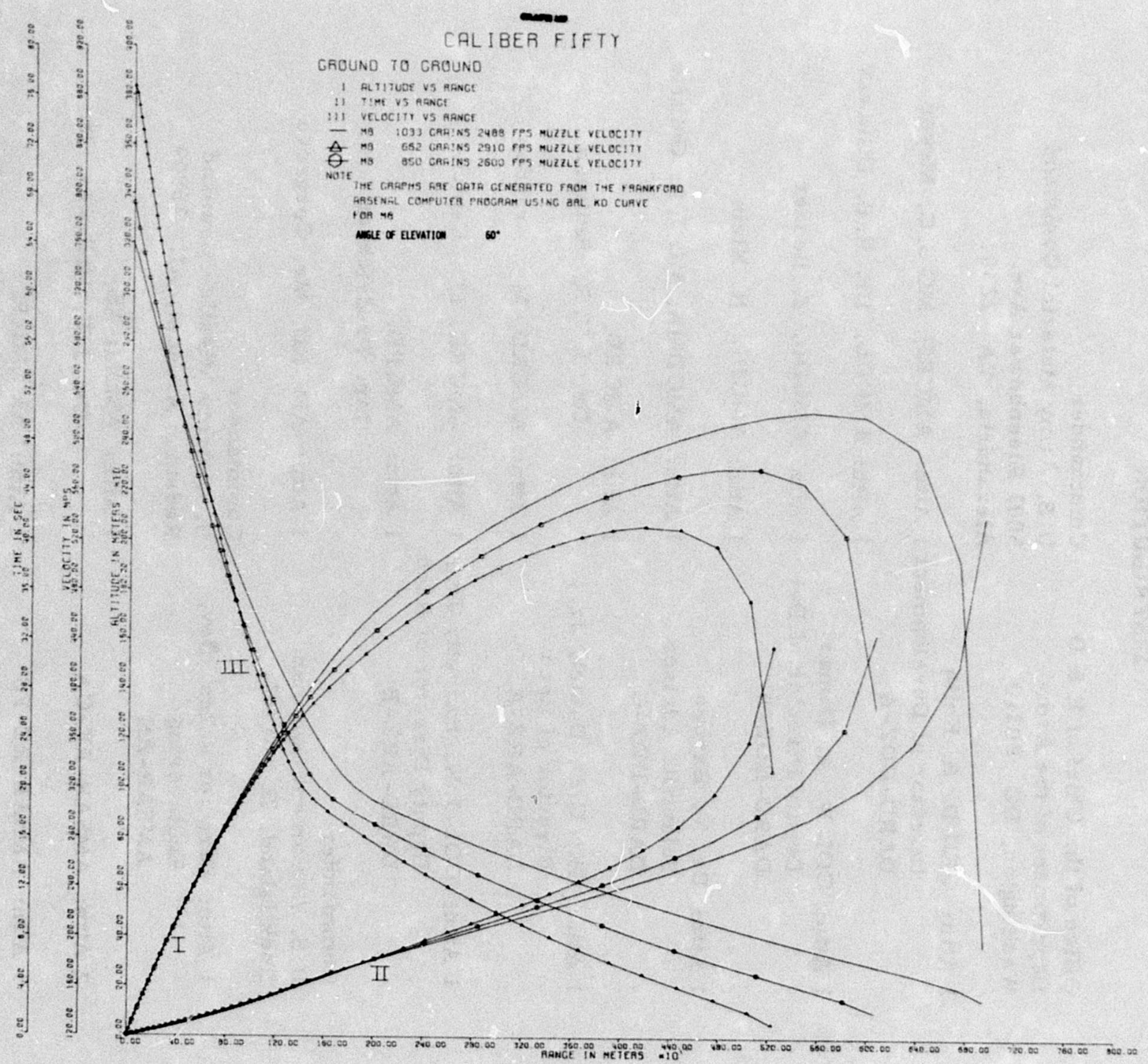
[redacted]



CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M8 1033 GRAINS 2488 FPS MUZZLE VELOCITY
M8 662 GRAINS 2910 FPS MUZZLE VELOCITY
M8 850 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BAL KD CURVE FOR M8
ANGLE OF ELEVATION 16°
I
II
III
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS ×10


CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M8 1033 GRAINS 2498 FPS MUZZLE VELOCITY
M8 662 GRAINS 2910 FPS MUZZLE VELOCITY
M8 850 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BAL KD CURVE FOR M8
ANGLE OF ELEVATION 30°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS
RANGE IN METERS *10
I
II
III


GRAPH 139
CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
M8 1033 GRAINS 2488 FPS MUZZLE VELOCITY
M8 662 GRAINS 2910 FPS MUZZLE VELOCITY
M8 850 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BAL KD CURVE FOR M8
ANGLE OF ELEVATION 45°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS ×10
RANGE IN METERS ×10
I
II
III


CALIBER FIFTY
GROUND TO GROUND
I ALTITUDE VS RANGE
II TIME VS RANGE
III VELOCITY VS RANGE
— M8 1033 GRAINS 2488 FPS MUZZLE VELOCITY
M8 652 GRAINS 2910 FPS MUZZLE VELOCITY
M8 850 GRAINS 2600 FPS MUZZLE VELOCITY
NOTE
THE GRAPHS ARE DATA GENERATED FROM THE FRANKFORD ARSENAL COMPUTER PROGRAM USING BAL KD CURVE FOR M8
ANGLE OF ELEVATION 60°
TIME IN SEC
VELOCITY IN MPS
ALTITUDE IN METERS ×10
RANGE IN METERS ×10
I
II
III

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